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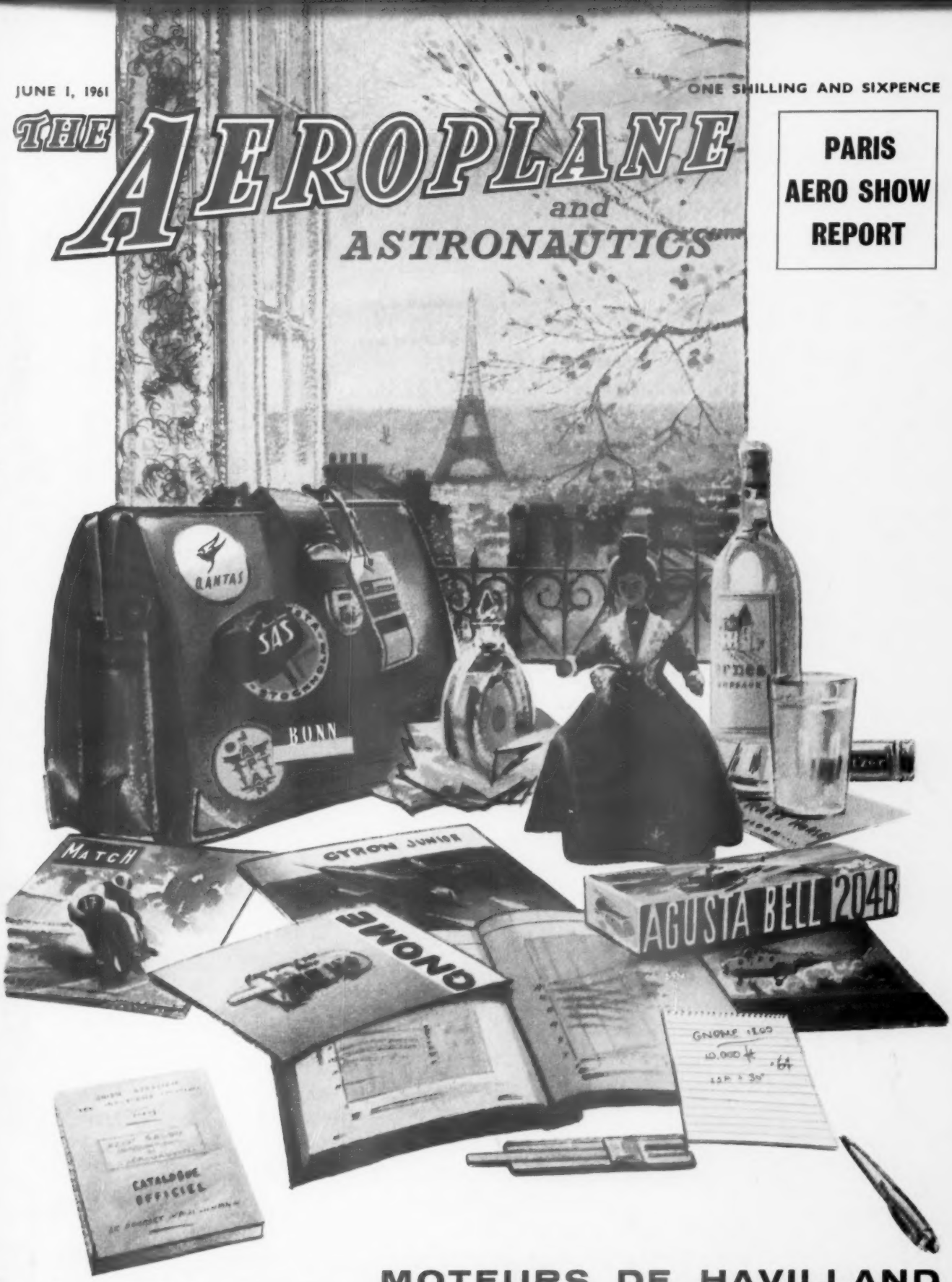

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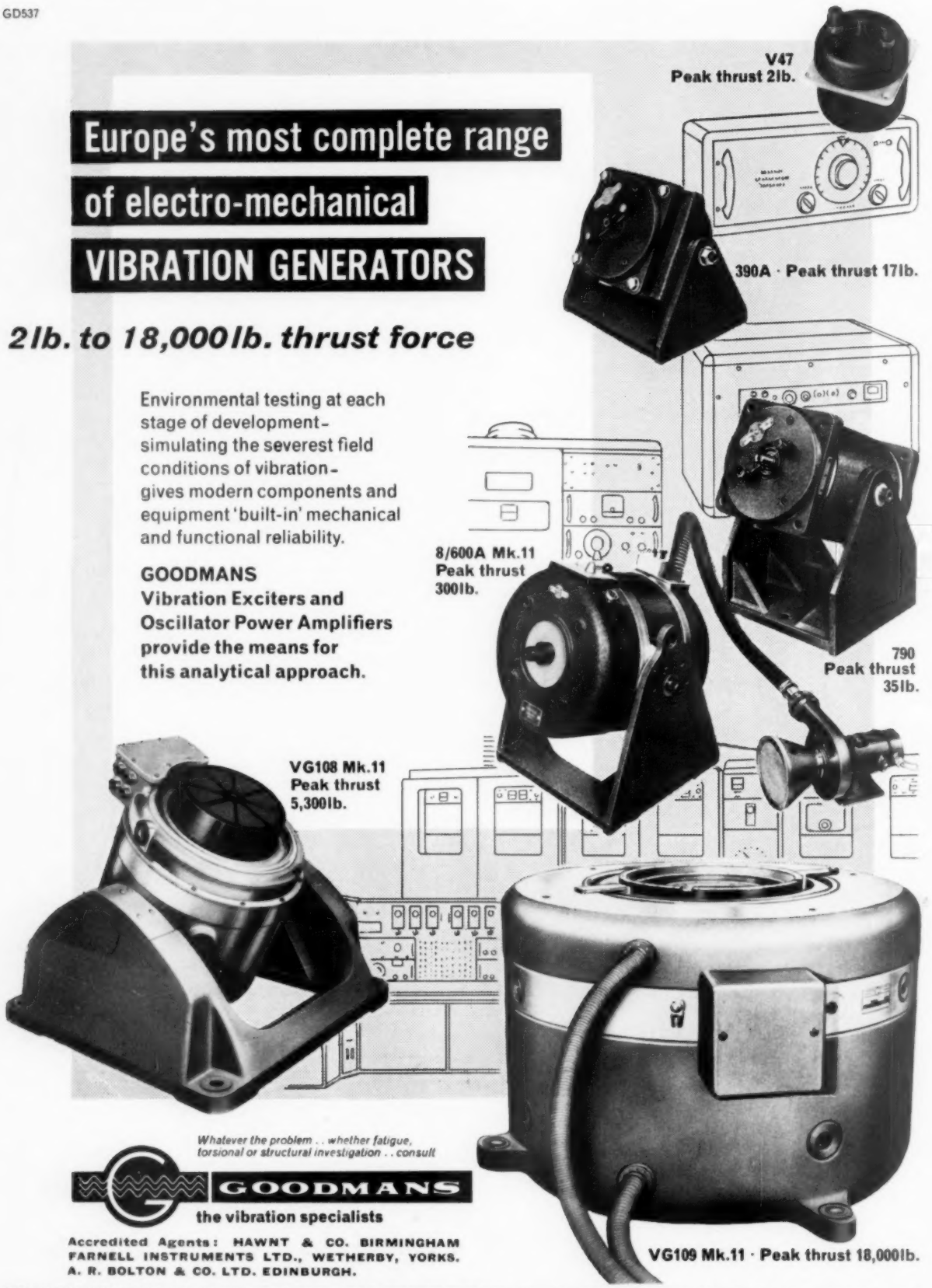

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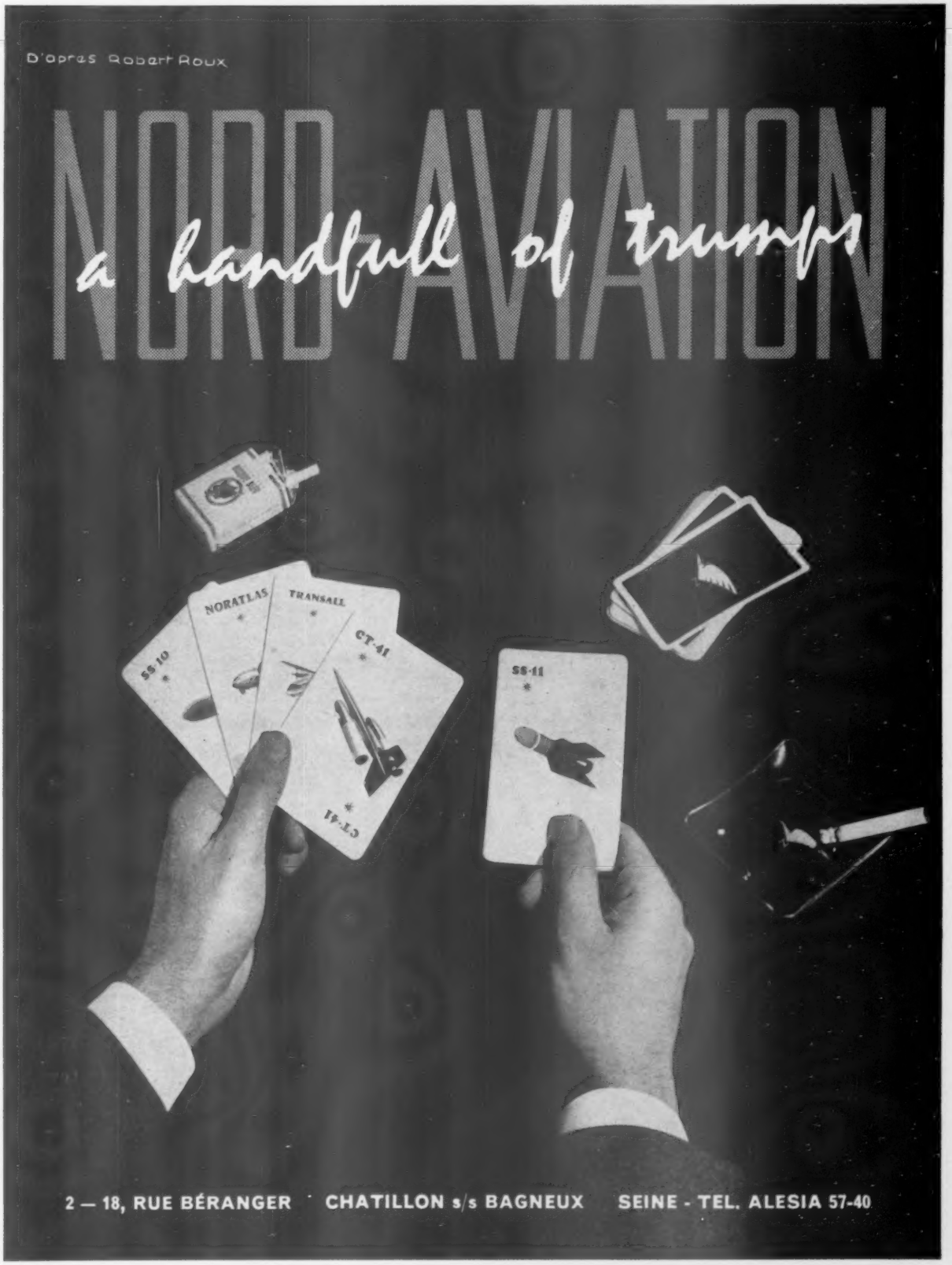
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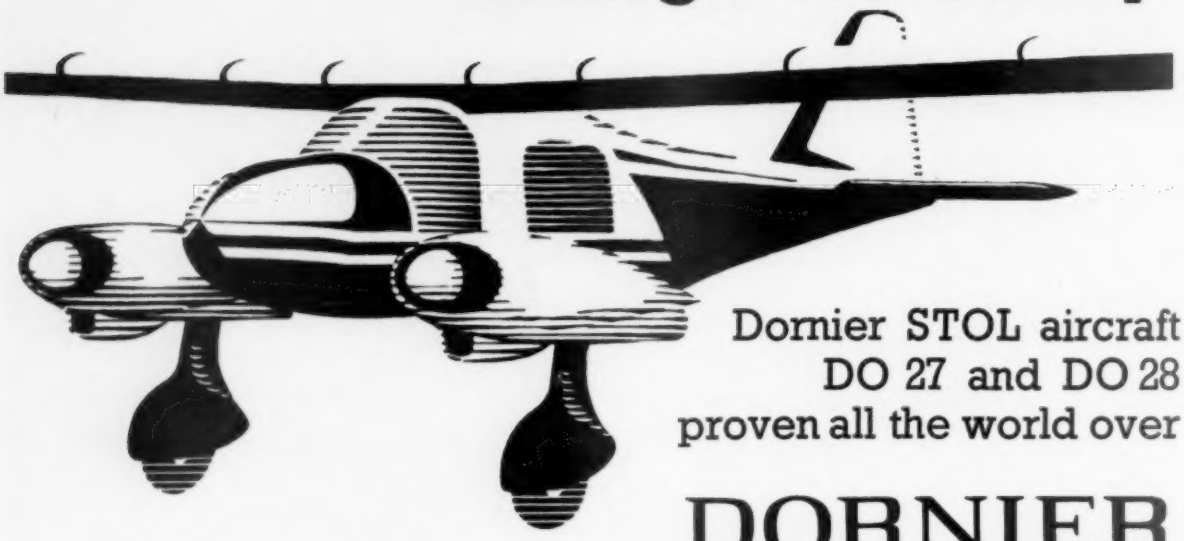

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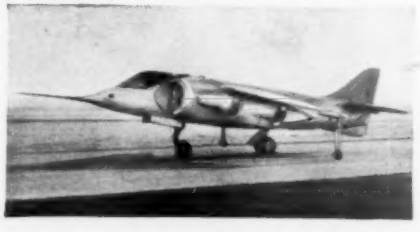

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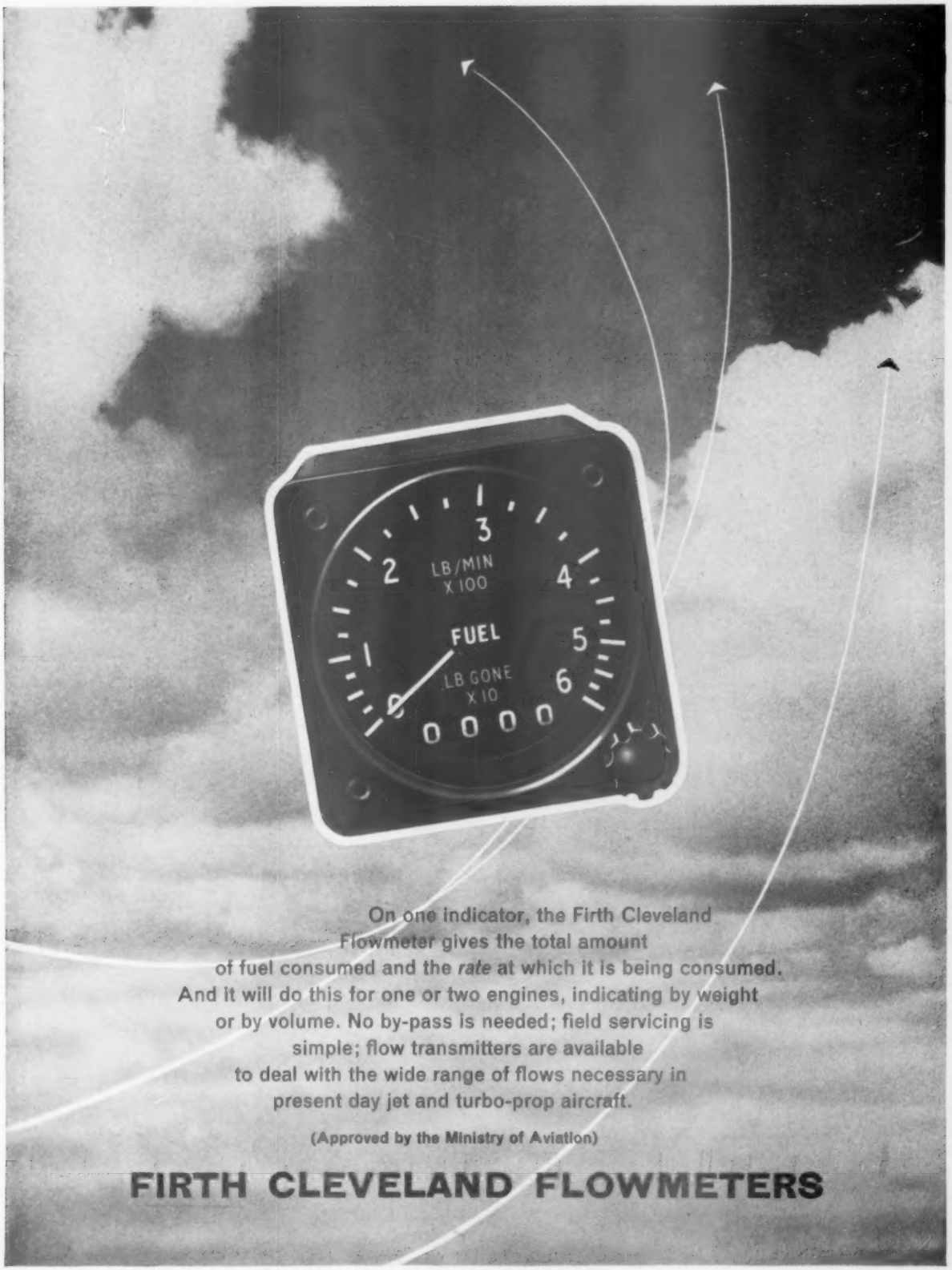

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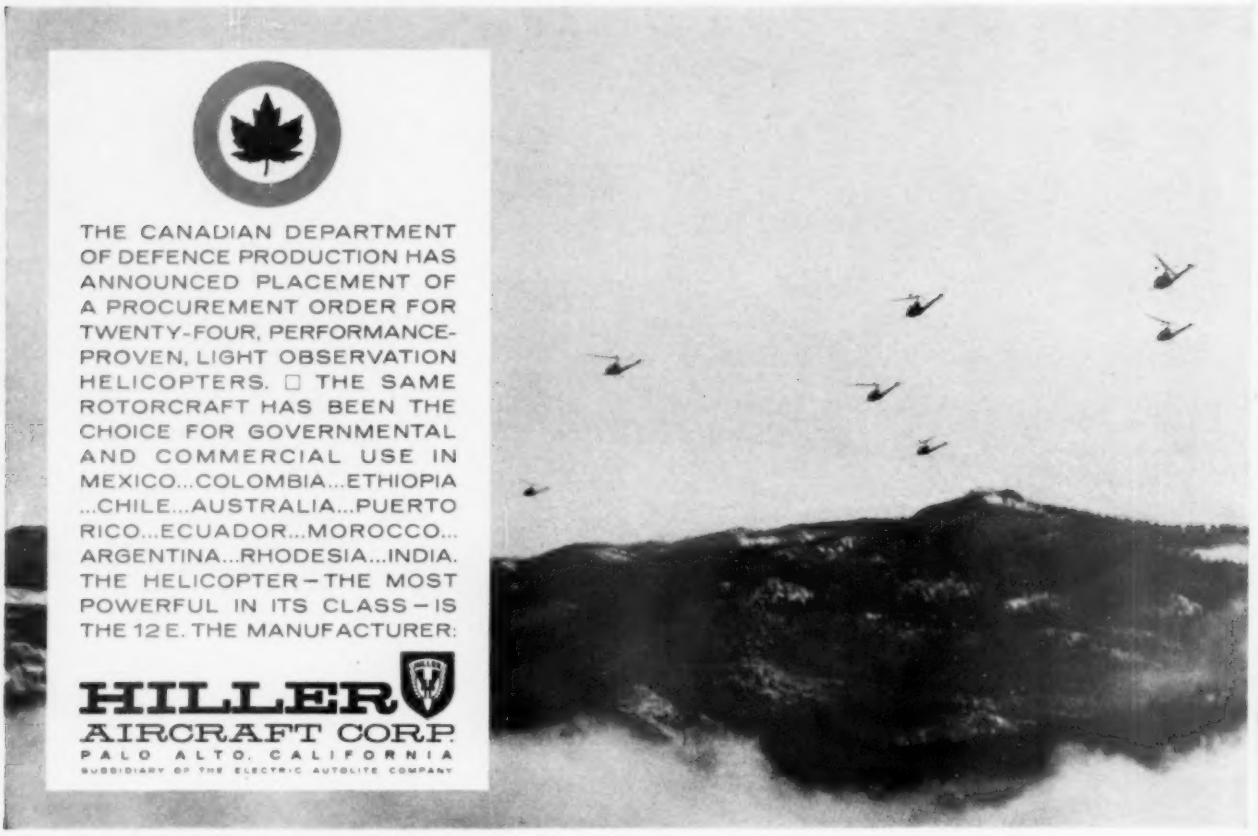
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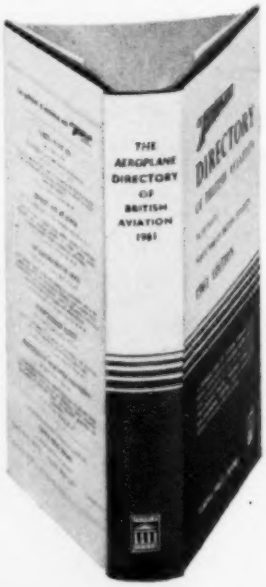

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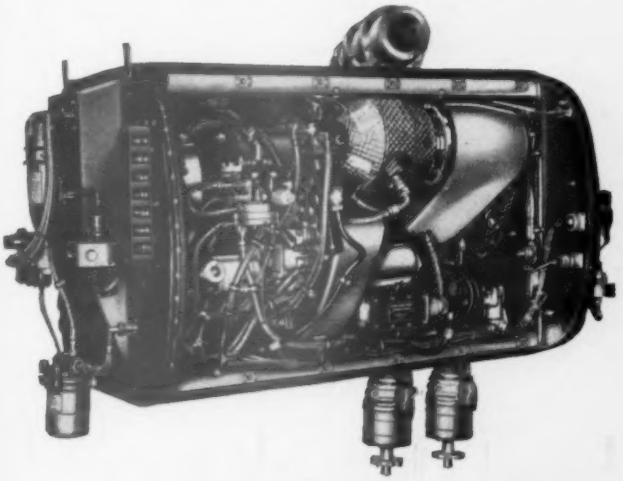

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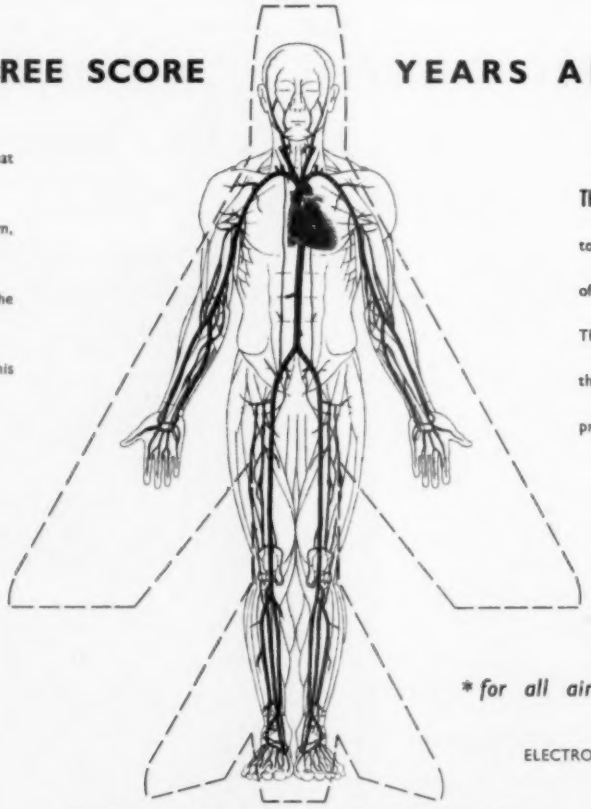

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THE AEROPLANE and ASTRONAUTICS

VOLUME 100 NUMBER 2589 JUNE 1, 1961

Aircraft Orders and the Future

On the eve of the Paris Air Show the two big British Aircraft Groups published particulars of their accounts for 1960. These figures are impressive regarding the information they give about the costs, and thus the complexity, of aircraft construction. They also give encouraging information about the amount of aircraft work in hand.

For instance, in 1960 Vickers sold 16 Viscounts representing over £8,000,000 without spares, three Vanguards and 10 super VC 10s. That last order represented £25,000,000. It was subsequently reported that the Government would contribute to the cost of developing this aircraft. By contrast the sum of £350,000 for a contract to Bristol Aircraft Corporation in October, 1960, to study supersonic airliner design seems quite a small amount.

The Hawker Siddeley Group for the 17 months to the end of December, 1960, were able to report record sales of £458,000,000; this covers all the Group's activities. A figure of special significance highlights the cost of developing private venture aircraft. The figure written off for this purpose stands at £15,649,000 and covers expenditure on the Armstrong Whitworth Argosy, the Avro 748, the de Havilland Trident, the de Havilland Caribou and the de Havilland Gnome.

The expenditure of bringing these aircraft to the marketable stage emphasizes the high costs of the design teams and development staffs. It emphasizes the importance that attaches to Government planning for future designs. If decisions are taken to buy foreign licences then no private firm can bear the expense unaided of maintaining its design staffs when no work is in prospect.

And this aspect is of special concern as the day draws ever closer when the Government must announce its decision to join the Common Market. In this context further information is awaited with anxiety about the agreements come to with the West German Government. In joint programmes decisions have to be made as to how far the sharing goes. Does one party undertake the design and the other the production or are both aspects jointly shared? What are the steps that will need to be taken to make the Hawker P.1127 design supersonic and in whose factories will the resultant NATO fighter be built?

As our recent report on the West European Aircraft Industry showed France and Germany have worked out answers to similar problems.

Moonshine or Not—the Race is On

In 1959 when the title of THE AEROPLANE was extended to cover ASTRONAUTICS there could have been few readers who would have believed that within two short years a president of the United States would be asking for funds from Congress to put a man on the Moon in a desperate effort to catch up with Russian progress in this field.

Understandably, when there are millions to whom the whole idea of a man in the moon is still moonshine, the contemplation of such a tremendous slice of national effort has something lunatic about it. However, the space race is on and no one can doubt that in this game no holds will be barred.

The techniques that have been developed and are going to be developed will be vital for industrial health. The problem before our leaders is how to deploy British technological enthusiasm in this field.

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Matters of Moment

Anglo-German Weapons

BRITISH aero-engine manufacturers seem likely to get the lion's share of the aeronautical side of the orders which Herr Strauss, the West German defence minister, discussed with Mr. Watkinson, the British Minister of Defence, on May 24. No values were given for the aeronautical business discussed, but it was reported that 200 tank guns for Germany and other immediate orders were worth £20 million. The following points made in the communiqué issued after the meeting are of particular interest to the British aircraft industry:—

"Herr Strauss . . . confirmed that the contract for 50 Seacat missiles was about to be completed.

"Direct orders for the Bristol Orpheus engine are being increased and substantial orders for Rolls-Royce Tyne engines are in prospect for the Transall transport aircraft which is under joint Franco-German development.

"The Ministers decided to conclude an early agreement for the joint development of a VTOL lightweight strike fighter aircraft on the basis of the Hawker P.1127 and also agreed to develop jointly, in association with France the Rolls-Royce RB.162 engine."

Only the last part of this statement reveals any new decisions in Anglo-German co-operation. The RB.162 is understood to be the latest Rolls-Royce jet-lift engine. The company has been reported as developing an engine of this type with a thrust-to-weight ratio of 16 : 1. It is said to be a simple and relatively cheap engine incorporating plastics in its construction.

If Britain, Germany and France are to collaborate on development and production of this engine, it would almost inevitably be selected for future VTOL types in a different category from the P.1127.

Bigger Than Ever

EVERY year, round about this time, we receive from the Society of British Aircraft Constructors some preliminary notes concerning their next Exhibition and Air Display. And for the past several years the general purport of these advance notices has been that the Show as a whole was to be bigger and better than its predecessors.

Significantly enough, despite the recent changes in the structure of Britain's aircraft industry, this most heartening trend continues. Last week the Society announced that the indoor part of their 1961 Show in September is to occupy "the largest tented structure in the World used to house exhibits at an aeronautical show." With an overall area of 130,400 sq. ft., it will in fact cover 5,000 sq. ft. more floor space than last year and will house 15 extra stands required by member companies.

So far as plans for the flying part of the display have been disclosed, it appears that Service participation will be extensive. The Royal Air Force will naturally play a leading rôle and it is good to learn that the Royal Navy are not repeating their non-participation of last year and will again take part. For the first time, the Society reveals, the Army is to fly its own aircraft at an S.B.A.C. Show. Army Air Corps pilots will be flying Skeeter helicopters; and, as another "first" at an S.B.A.C. Display, parachutists are to take part.

To date, the Society has completed 96 flying programmes—out of which only one has had to be cancelled because of bad weather; although some have had to be restricted. In point of fact, the flying programme on the Thursday at this year's Show will be the 100th staged by the S.B.A.C. since is started the displays at Hendon in 1932. Most certainly this is a record of which the Society and the industry it represents have every reason to be proud.

The Lesson of the Redstone

ONE aspect of the recent successful American attempt to fire a manned rocket has not perhaps received the publicity it should. The single-stage rocket used for boosting the manned capsule into space was a Redstone. Equally, it was a Redstone rocket that, fortified with three solid-fuel stages, put the first American satellite into orbit. The Redstone is the brainchild of Wernher von Braun who played so large a part in developing the V-2. These facts have particularly ironic significance in the United States where the Redstone was produced for the U.S. Army which was eventually eased out of the space race with the result that von Braun and his team were transferred to the Marshall Space Flight Center. In spite of this it was a well-tried Army rocket of a decidedly obsolescent pattern that lifted the first U.S. astronaut above the atmosphere.

The irony may not seem of significance in this country but the facts surely are worth recording. There is still no way of winning any race other than by starting in time. The more difficult the problem or venture, the more necessary become step by step proving and the accumulation of experience.

Twenty years of practical rocket experience lay behind the successful operation with the manned Mercury capsule. It is quite certain that the Russians will have gained their success by similar accumulation of experience. It is painful to think how many years must elapse before this country might achieve similar results based on experience accumulated by our own establishments.

More Flying on Television, Please

DO the B.B.C., or I.T.A. for that matter, devote enough time to the doings of the Royal Air Force? We have no means of investigating the matter, but so far as personal experience goes we do not seem to have seen recently any plays or films with R.A.F. flavour. Perhaps we have just missed them in the gamble of switching on and off. On the other hand, we saw a splendid Naval film on television the other evening about a lease-lend destroyer.

The Royal Navy, ever since we can remember, has had a strong dramatic appeal. Was not the youthful hero of the first

LOW STRIKER.—Official confirmation that the Mk. 2 Buccaneer for the Royal Navy will be powered by Rolls-Royce Spey turbojets, was given last week. This latest photograph from Blackburn Aircraft shows a Buccaneer 1 simulating a characteristic low-level approach to its target.

POWERFUL PUNCH.—No fewer than 124 two-inch rocket projectiles can be fired in a salvo from Sea Vixens equipped with the latest arrangement of Microcell glass-fibre armament packs; here the standard pair of 14-rocket packs can be seen. Discussions are being held on the Continent with a view to the possible adoption of the British 2-in. RP as standard armament for NATO fighters and strike aircraft.

play we went to, "Where the Rainbow Ends," a midshipman? Then there were tales of "Bartimeus" and "Taffrail" and for drama "The Flag Lieutenant."

While we were pondering on this seeming omission a reader wandered along to congratulate our photographic staff on the superb shots of the No. 74 Sqn. Lightning in our issue of May 18. He then confirmed our feelings on the matter by asking what could be done to get more pictures of the doings of the Royal Air Force on the television screen. He asserted vigorously that thousands of people like to see good air-to-air shots of aeroplanes, and, if they are Royal Air Force aeroplanes, so much the better.

When one thinks of all the far places of the earth that the R.A.F. flies over and from, there can be no doubt of the possibilities. A camera bolted to the front end of a Prestwick Pioneer could get some staggering shots of getting in and out of Malayan landing strips.

The B.B.C. should remember that it is a pretty safe bet that the family and relatives of each member of the Royal Air Force will count a high percentage of viewers among their number. All of them would welcome more shots of the R.A.F. at work. There ought to be plenty of material in the work of Transport Command also.

Finally, what about a film of the Lightnings of No. 74 Sqn. working up for a demonstration performance? There seems no shortage of material.

Moves Toward an Airports Authority

LAST week's news that the Ministry of Aviation had formulated a proposal that airport ground services at London Airport should in future be the responsibility of a consortium of user airlines made welcome reading. Apron services—baggage loading and handling, the positioning of passenger steps, and airport coaches for passengers—provided at L.A.P. by the Ministry, have long been a bone of contention between British and foreign airlines on the one hand and M.o.A. on the other.

Not the least of the complaints has been one of inefficiency—that there was a lack of central control over the various sections. Financially, the services—which are on a 24-hr. basis employing a staff of about 600—are said to have lost heavily since they were brought into being in 1955. Before then they were operated by the airlines themselves, either directly or, in some cases, by B.E.A. and B.O.A.C. on an agency basis; and the users had nobody to blame but themselves if the services failed.

These new proposals would seem to be a return to the pre-1955 arrangement with the responsibility placed firmly on the users. They can also be regarded as an indication that the Government is becoming more sympathetic to the idea that it might be better for it to relinquish direct control of airports. We have long advocated having an airport authority on the lines of the Port of London Authority; the Minister of Aviation has already indicated that proposals on such lines are being considered.

So far as the control of ground services is concerned, the present proposition is that the consortium of British and foreign airlines—The Airline Representative Board, United Kingdom—will take it over. According to reports, a separate company might well be formed for this task.

A Space Challenge from America

"I BELIEVE this nation should commit itself to achieving the goal, before the decade is out, of landing a man on the Moon and returning him safely to Earth." These words were used by President Kennedy when he addressed a joint session on Congress on May 25 in which he urged the United States to meet the "extraordinary challenge" facing the country in space development. "No single space project in this period," he said, "will be more exciting, or more impressive, or more important for the long-range exploration of space—and none will be so difficult or expensive to accomplish."

To achieve this end, the President asked Congress to raise American spending on civilian space projects by an additional $7,000m. to $9,000m. (£2,500m. to £3,214.3m.) over five years.

Where is the money likely to go? First, it will help to expedite the development of America's largest rocket booster, the Saturn, particularly the four-stage C-2 version which is yet to receive a specific go-ahead. The first of the C-1 boosters is scheduled to be launched this year at Cape Canaveral with two dummy upper stages.

The Saturn programme is the key to NASA's Apollo project, which has the double aim of developing a three-man space-laboratory orbiting the Earth, and of sending three men on a reconnaissance mission around the Moon and back to Earth. The original aim was to accomplish this latter objective by 1967.

To meet the threat of bigger Soviet rocket boosters, it seems imperative that the United States should press ahead with the development of the big single-chamber Rocketdyne F-1 engine of 1.5m. lb. s.t. The Rover nuclear rocket programme may also be accelerated. And because large solid-propellent engines hold promise of reducing the development time of space-boosters, a parallel programme of massive segmented "solids" is almost certain to evolve.

Then, finally, America must define its method of reaching the Moon and landing on it. Dr. Wernher von Braun, whose team at the Marshall Space Flight Center in Huntsville is responsible for Saturn, has suggested that this could be achieved with Saturn C-2 using five of these vehicles as "tankers" to refuel the outgoing spaceship in orbit around the Earth. On the other hand, much paper study has been devoted to achieving the Moon-landing mission in "one go," using a multi-stage Nova vehicle employing a cluster of six 1.5m. lb. thrust Rocketdyne F-1 engines in its first stage.

Where does all this leave the rest of the World? One cannot help feeling that in the major "prestige race" that is developing with Russia, the United States, despite its huge commitment of funds for space-development, will be stretched to the limit by the end of the present decade in fulfilling a programme on this scale. The carefully thought-out programmes of scientific research, now being carried out, and the hopes for the application of satellites for commercial purposes—to say nothing of the already big military space programmes—must all be followed through if the whole structure of the American space effort is not to be seriously undermined.

There is a lesson here for the European space programme in that, in the race for the Moon, Russia and America are bound to leave gaps in the overall programme of scientific research and endeavour which will be lucrative in their own right. It is thus more important than ever that we push ahead, with all speed, with a European heavy satellite launcher.—K.W.G.

Executive Operators Unite for Action

AFTER several months of formative work, the Business Aircraft Users' Association came into official being on May 23, with nearly 40 of the biggest companies in British industry as founder members. As we have mentioned during earlier discussions on the B.A.U.A., its aims and objects are wide, and range over practically every interest involved in the development of business flying in and from the U.K., to aid the export drive. Among the priorities are airport facilities for business aviators, in the London area and in locations convenient for other cities.

Headquarters of the B.A.U.A. are at Londonderry House, and its chief executive is Sqn. Ldr. R. R. Stephenson. The first Council comprises Messrs. M. A. H. Bellhouse (Pressed Steel), chairman, Hector Laing (McVitie and Price), Kenneth McAlpine (Sir Robert McAlpine and Sons), T. S. Kilpatrick (United Steel), Geoffrey Woods (Woods of Colchester), E. W. Pasold (Pasolds, Ltd.), L. H. Riddell (Yorkshire Patent Steam Wagon Co.), J. Riseley Prichard (Willis, Faber and Dumas), R. A. Smith (Oxford Aviation), T. A. Vigors (Vigors Aviation), Peter G. Masefield (R.Ae.C.) and Col. R. L. Preston (R.Ae.C.).

With other companies included among the founder members are such well-known names as the British Motor Corporation, David Brown, Rolls-Royce, Rootes Group, British Oxygen, I.C.I., Jaguar Cars, Triplex, Esso, Shell-Mex and B.P., and many others. In acting as official spokesman for these, the B.A.U.A. will "ensure that the needs of business aviation are fully appreciated on all questions and if necessary bring any available pressure to bear to ensure this appreciation at the highest level."

Starting the Air Show Season

THE Royal Air Force turned out in strength on Whit Monday to provide the greater part of the flying programmes which more than 140,000 people enjoyed at North Weald, Hucknall and Yeadon. Much credit is due to the air and ground crews for performing so efficiently after having had little respite after the exertions of Exercise "Mayflight/Matador."

At the R.A.F.A. show at Hucknall (55,000) and the S.S.A.F.A. one at Yeadon (40,000) low cloud curtailed parts of the programme but at North Weald (48,000), where R.A.F.A. were again the organizers, near perfect conditions prevailed.

Here the star Service attractions were the aerobatic teams of No. 92 Sqn. and the C.F.S. The "Blue Diamonds," making their first public appearance in this country, came well up to expectations and were hard to fault. With experience they will no doubt develop the polish and finesse of their predecessors, 111 Sqn., whose aerobatic beginnings were at North Weald.

The new C.F.S. Jet Provost team, its aircraft now bearing the conventional Flying Training Command "day-glow" markings were also well received on their first airing.

A demonstration of ground defence by No. 33 (Field) Wing, R.A.F. Regiment provided welcome relief from craning one's neck skywards. Flypasts by a Britannia, Valiant and Shackleton were all performed in an efficient manner even if a little drawn out.

Representing the aircraft of yesteryear were the familiar Spitfire and Hurricane performing their tail-chasing with gay abandon; for a lady of such certain age the Shuttleworth Collection's Gloster Gladiator showed amazing agility.

U.S.A.F. participation was disappointing. Once again the KB-50J giving the air refuelling demonstration was late and during its two flyovers the attendant B-66 and F-101 Voodoo were never once linked up. The F-100 which should have completed the thirsty trio arrived later.

Executive and personal aircraft turned up in force. The dead stick landing by an Aircoupe, a single-engine climb away by an Aztec and the pass down the runway by a Chilton held just above the stall were all very worth while. Providing the finale was the Swiss aerobat Francis Liardon flying a Jungmeister. His demonstration was a masterly finishing touch to a satisfying afternoon.

Penalizing the Private Pilot

IT would be interesting to speculate what offences against the normal civil code one could commit, to incur a penalty of £260. This was the total, made up of a £110 fine and £150 contribution towards costs, inflicted on Tiger Club chairman Norman Jones last week at Aylesbury Quarter Sessions. They seem extraordinarily severe sums in view of the technical nature of the offences which were: failing to satisfy himself at Panshanger that a flight to Redhill could safely be made; failure to examine meteorological reports; failure to notify flight plans at Denham and to inform of his landing at Denham.

Norman Jones explained that he had rung Redhill for a weather report and had flown towards High Wycombe (round the zone) in his Piper Cub. In deteriorating weather, he followed the railway line and the River Colne to Denham, where he asked someone in charge of a hangar to let air traffic control know of his landing. He was fined £100 for failing to ensure the flight was safe and £5 on each of two charges of failing to obtain weather reports and to give notice of landing. A fourth charge alleging he entered the London Control Area without permission was dismissed.

It is important that air safety regulations be carefully regarded by all pilots in the interests of universal security, but it is equally vital that any suspicion should be avoided of victimization against individuals who have not endangered others by their actions. In this case, the penalties appear to be out of all proportion to the offences.

Opening the National Air Races

ALTHOUGH the King's Cup on Jly. 14-15 and its qualifying events this coming week-end are thrown open for the first time to foreign aircraft, on condition that these are entered and raced by British nationals, relatively few owners of the many new American types now flying in this country have taken advantage of the relaxation in rules. Of the 38 entrants for the London-Cardiff race on Friday, Jne. 2, and the closed-circuit races from Rhoose on Jne. 3, only three examples of the new generation of American light aircraft—an Aircoupe, a Cessna 180 and a Cessna 210—are represented.

Interest will not be lacking, however, from the remaining miscellany of types, which in addition to the familiar racing veterans this year includes several ex-World War II fighters, in the form of two Spitfires and a Mustang. One of the Spitfires is the well-known Mk. 8 trainer of the Hampshire Aero Club, flown as usual by Vivian Bellamy, but entered on this occasion by Admiral of the Fleet Earl Mountbatten. Beverley Snook is flying a Belgian-registered Spitfire Mk. 9, OO-ARE, and third competitor in the high-speed league will be Ron Flockhart in Mustang Mk. 20 G-ARRD. Last year's King's Cup winner and air racing champion John Severne, is again flying the Turbulent 'PNZ, racing number seven, entered as before by H.R.H. The Duke of Edinburgh.

Prince Philip is to visit the Glamorgan Flying Club at Rhoose Airport to watch the end of the London-Cardiff race, which starts at Panshanger at 16.15 hrs., and is due to finish at Rhoose around 17.30. The course of about 145 miles is via a check pylon at Weston-super-Mare.

For the purpose of qualification for the King's Cup at Baginton, on Jly. 14-15, the entries will be divided into three classes and equal points awarded for each class in order of finishing. The three handicap class races to be flown at Rhoose on Saturday will be over three or four laps of a course of which the lap distance will be approximately 11 miles. A full programme of aviation events has also been arranged.

Entries for the London-Cardiff and class races, with racing nos., pilot, entrant (where different), aircraft and registration are:—

Class 1, **Air League Challenge Cup,** No. 80, P. Blamire, Miles Gemini 3C, G-ALZG; No. 99, V. H. Bellamy, Earl Mountbatten, Spitfire Mk. 8, G-AIDN; No. 68, E. Crabtree, Proctor 3, G-ALFX; No. 88, P. Dawson, Proctor 4, G-ANZJ; No. 90, L. Richards, P. A. Fitzpatrick, Cessna 180C, G-ARAT; No. 72, T. G. Knox, Proctor 3, G-AIHD; Wg. Cdr. R. H. McIntosh, M. D. N. Wyatt, Cessna 210, G-ARDC; No. 96, R. R. Paine, Miles Hawk Speed Six, G-ADGP; No. 63, Capt. G. P. Watson, Proctor 3, G-AOEJ; W. R. Flockhart, B. Winslett, North American Mustang Mk. 20, G-ARRD; A. J. Spiller, Proctor 3, G-AHFK; B. J. Snook, Spitfire 9, OO-ARE; G. Marler, Falcon 6, G-ADTD; K. B. Neely, Proctor 3.

Class 2, **Norton-Griffiths Challenge Trophy,** No. 43, S. M. Aarons, Hawk Tr. III, G-AIUA; No. 3, Sqn. Ldr. C. P. Francis, Turbulent, G-ARIZ; No. 34, C. Gregory, Taylorcraft Plus D, G-AHGZ; No. 48, D. M. Hartas, Arrow Active II, G-ABVE; No. 35, Sqn. Ldr. H. B. Iles, Miles M-18, G-AHKY; No. 4, N. H. Jones, Turbulent, G-APIZ; No. 41, Flt. Lt. R. Crowhurst, A. J. Linnell, Comper Swift, G-ABUS; No. 19, P. G. Masefield, Chipmunk 22A, G-AOTM; No. 12, Miss M. A. Mckellar, Turbulent, G-APMZ; No. 7, Wg. Cdr. J. de M. Severne, H.R.H. The Duke of Edinburgh, Turbulent, G-APNZ; No. 2, B. Tempest, Turbulent, G-APZZ; No. 25, E. F. Thurston, Aircoupe, G-ARHA; No. 57, Flt. Lt. A. Turley, Miles Hawk Tr. III, G-AIVE.

Class 3, **Tiger Moth Challenge Trophy,** No. 15, C. A. Nepean Bishop, Tiger Moth, G-ANMZ; No. 20, J. M. Donald, Tiger Moth, G-ANZU; No. 22, C. E. Elton, Tiger Moth, G-ANZZ; No. 17, F. R. E. Hayter, Tiger Moth, G-AREH; No. 21, J. W. C. Judge, Tiger Moth, G-ACDC; No. 18, B. G. K. Maile, N. H. Jones, Tiger Moth, G-ARAZ; No. 16, G. Rees, Tiger Moth, G-AOUY; No. 52, Miss Sheila Scott, Jackaroo, G-APAM; No. 28, The Hon. Peter Vanneck, Tiger Moth, G-APRA; No. 30, Miss J. L. Ferguson, W. P. Meynell, Tiger Moth, G-ANEL; No. 14, I. Trethaway, B. J. Snook, Tiger Moth, G-AOAA.

Aviation News in General

CANADAIR CL-41R.—Canadair is offering to the R.C.A.F. and other users of the Lockheed F-104, an advanced systems trainer derived from the CL-41. It would have a long, tapering nose housing F-104-type radar and a pitot boom; other features would be an electrical bay containing a 3,000 V.A. inverter and inertial navigation platform components, and standard F-104 form factor packages in the engine bay area, causing a slight bulge in the fuselage. Student and instructor location in the cockpit are reversed, compared with the CL-41 basic jet trainer. The latter first flew on Jan. 13, 1960, and two prototypes have completed 220 flights and about 175 hours.

LONDON-PARIS.—On May 30, a production Westland Belvedere was to fly direct from the Westland Heliport, London, to the Paris Heliport at Issy les Moulineaux with the flight being officially observed by the Royal Aero Club. After clearing Customs at Issy the Belvedere was to fly on to Le Bourget to take part in the Paris Show.

B-52H DELIVERED.—First turbofan-powered B-52H was delivered to the 379th Strategic Wing of S.A.C. at Wurtsmith A.F.B. on May 9.

RALLYE SET-BACK.—The Morane-Saulnier M.S.880 Rallye 02 prototype, definitive version of this widely ordered three-seat tourer, crashed during its certification flight trials from the French flight test centre at Bretigny, killing its pilot, M. Jean Person. The accident occurred during spinning trials at extreme aft C.G. position.

PHANTOMS' FLIGHT. — A new record for the coast-to-coast crossing of the U.S. has been set up by three Navy F4H-1 Phantom IIs. A time of 2 hr. 47 min. was recorded for the fastest of the trio. The Phantoms left Ontario, Calif., and were flight refuelled at three points before landing at Floyd Bennett Field, Brooklyn.

MUSEUM PIECE.—The Rolls-Royce Flying Bedstead thrust measuring rig is to become part of the National Aeronautical Collection housed in the Science Museum.

EXIT CONVAIR.—Under a reorganization announced recently the name Convair has been dropped by General Dynamics, and the company is divided into five new General Dynamics Divisions —Astronautics, Fort Worth, Pomona, San Diego and Daingerfield. The operational headquarters of the Corporation are to be moved to San Diego, and the former Convair general office there will be eliminated.

NEW HILLER.—A full-scale mock-up of the Hiller Model 1100 light observation helicopter. This design and the Bell D-250 have won the competition for a single U.S. Army helicopter to replace the L-19 Bird Dog aircraft and the H-13 Sioux and H-23 Raven helicopters. Prototypes will be evaluated; both are four-seaters powered by Allison T63 turboshafts.

Golden Jubilee

Next week THE AEROPLANE AND ASTRONAUTICS celebrates its 50th year of publication. In the much enlarged special issue appearing on Jne. 8 will be highlighted the historical achievements of the industry it was founded to serve. The supplement will also contain an extract from the unpublished reminiscences of the founder editor, the late Mr. C. G. Grey. This issue will cost the usual 1s. 6d.

OPEN DAY. — Alconbury, near Huntingdon, base of the RB-66 equipped U.S.A.F. 10th Tactical Reconnaissance Wing, will be open to the public between 10.00 hrs. and 17.00 hrs. on Saturday, Jne. 17. Included in the static and flying displays of current U.S.A.F. and R.A.F. types will be the C.F.S. Jet Provost aerobatic team, a formation of Lightnings and a B-52.

FOR P.P.L.s.—The 1961 edition of C.A.P.53 ("The Student Pilot's and Private Pilot's Licences") is now available from H.M.S.O., price 2s. 6d. (by post 2s. 8d.).

HELICOPTER HEIGHT. — The U.S.A.F. is to submit 25,814 ft. as a new helicopter Class height record to an F.A.I. This was attained by a Kaman H-43B Huskie piloted by Capt. W. C. McKeen on May 25. The record height was reached one hour after take-off.

U.S.A.F.E. F-105s. — The first 12 Republic F-105D Thunderchief fighter-bombers for the U.S.A.F. in Europe have arrived at Bitburg A.F.B., Germany, for operation by the 36th Tactical Fighter Wing. The second unit to convert from F-100s to F-105s will be the 49th T.F.W. at Spangdahlem. Flight refuelled, the 12 F-105s flew direct from Mobile, Ala., to Bitburg in approximately 9 hr.

TURBOPROP PORTER.—A Pilatus P.C.6 Porter has been fitted with a Turbomeca Astazou turboprop in Switzerland, and first flew on May 2.

GOING UP.—Piloted by NASA chief test pilot Joe Walker, a North American X-15 reached 3,370 m.p.h. on May 25. This exceeds by 296 m.p.h. the speed reached by Maj. Robert White on Apr. 21. The X-15 was released from a B-52 at 45,000 ft. Maximum speed was reached in a steep climb to 90,000 ft. after which the rocket motor was cut out and the aircraft coasted a further 20,000 ft. before the glide back to earth. The flight lasted 13 min. (Unconfirmed figures.)

EUROPE'S SPACE PLANS.—There is now a good prospect that Germany will join the Franco-British project to develop Blue Streak as a European heavy satellite launcher. Herr Strauss, the German Defence Minister, completed talks with Mr. Thorneycroft, Minister of Aviation, and Mr. Watkinson, Defence Minister, on May 25.

JAPANESE EXPORTS.—It is reported that the Japanese may sell five of their Kappa-series high-altitude rockets to Argentina at a cost of £285,000. Kappa research rockets have already been purchased by Yugoslavia.

DYNA-SOAR BOOST.—Boeing have given the Thiokol Chemical Corp. a contract to develop a boost rocket for Dyna-Soar, both to increase overall performance and to act as a separation device for the glide-vehicle should the launching rocket fail at take-off. The unit will consist of a motor case, solid-propellent, thrust vectoring device, and igniter.

CESSNA CARGO-PACK.—A glass-fibre cargo pack of 21.5 cu. ft. capacity for low-density loads has been developed for the Cessna 185 Skywagon. Its installation is claimed to leave the Skywagon's 950- and 470-ft take-off and landing distances unaffected.

JUNO FAILS.—The attempt to launch the S-45 ionosphere beacon satellite described on page 638 of this issue failed on May 24 when the second stage of the Juno II booster failed to ignite.

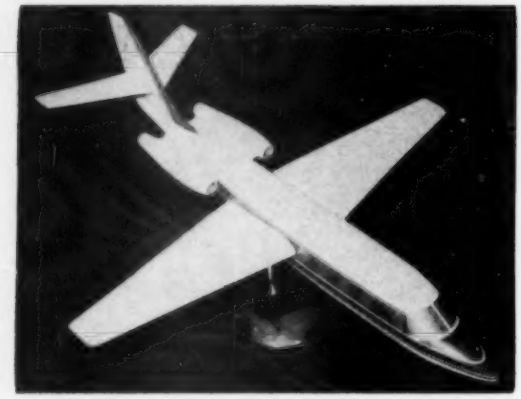
MOON PROGRAMME.—Next steps in Russian exploration of the Moon will include the landing of special apparatus on its surface, according to a report in the Soviet *Economic Gazette*. Other parts of the programme will include satellites orbiting the Moon while in radio and television contact with the Earth; the launching of a rocket from the Moon to return safely to Earth and finally the dispatch of a manned spaceship.

CORRECTION.—With regard to his article, "Spaceplane Propulsion," published last week, Mr. Stuart Greenwood has asked us to point out that Fig 5 contains an error. The arrow indicating the operating line for maximum efficiency in the graph showing "Effects of flight speed on internal compression inlet" should, of course, apply to the lower curve.

BLUE SCOUT.—First complete failure in six launchings of Blue Scout I from Cape Canaveral occurred on May 9 when the 72-ft., four-stage rocket veered off course as its second stage ignited. It was carrying a payload of instruments for radiation studies.

SPACE RESEARCH IN ITALY.—An aerospace research centre has been opened in Rome on behalf of the local university. It is planned to include a Mach 12 wind-tunnel.

Commercial Aviation Affairs



JET COMMANDER.—This turbojet successor to the Aero Commander is scheduled to fly in 1962. It has two 2,850 lb. st. General Electric CJ610s and will cruise, with 6-8 passengers, at Mach 0.8 above 20,000 ft. Its weight is 14,000 lb.; span, 43 ft. 4 in.; length, 48 ft. and height 14 ft. 9 in. Basic price will be $475,000 and equipped price $600,000.

NEW B.O.A.C. ROUTES.—U.S. presidential approval has been given to B.O.A.C. for the extension of its present route through New York to the Bahamas and Jamaica. The new permit allows B.O.A.C. to serve Cuba, Panama, Colombia, Ecuador, Peru (Lima) and Chile (Santiago) on flights from or to London, Manchester or Prestwick through New York.

INTERNATIONAL AGE LIMIT.—By a small majority the ICAO Personnel Licensing and Medical Division voted to recommend an age limit of 60 for airline transport pilots. At a recent meeting of the Division in Montreal, 34 nations and organizations were represented. The recommendation, which now goes to the ICAO Air Navigation Commission and will also need the approval of the full ICAO council, was based on the increased possibility of sudden incapacity in a pilot with advancing age.

AMERICAN FINANCES.—A net loss of $1.97 million was recorded by American Airlines in the first quarter of 1961, compared with $450,000 in the same quarter in 1960. The blame was placed by American on the strike of flight engineers, unusually bad weather, depressed business conditions and excessive capacity on many principal routes. According to Mr. C. R. Smith there are now "tangible indications of a moderate upturn in the total economy and the airline business."

MORE FORTY-FOURS.—Canadair, Ltd., has been told by the Canadian Government that an order for five swing-tail versions of the CL-44 is being drawn up, and these aircraft are being added to the production line. Slick Airways, who already have two CL-44s on order, has expressed its intention of purchasing a further two.

C.P.A. INAUGURALS.—Canadian Pacific Airlines has taken delivery of its first two Conway-engined DC-8s and will inaugurate service with them on the Vancouver-Edmonton-Amsterdam-Rome route on May 31. During the first week in June they will also go into service between Vancouver and Montreal, and on the route from Montreal to Rome by way of Lisbon and (westbound only) Santa Maria in the Azores.

E.A.A. PROGRESS.—East African Airways recorded a profit of £452,688 on its 1960 operations. The number of passengers carried increased by 14.6% to just short of 150,000; cargo increased by 13.9% to 2,900 tons.

INDIAN OVERHAULS.—A test plant is to be set up by Air India in Bombay to handle Rolls-Royce Conways at the rate of 10 a month.

BELL AWARDS.—Laurence D. Bell Helicopter Pioneer Awards will be made this year to British United Airways, the Canadian Department of Transport and the Brazilian Department of Agriculture. The awards, initiated last year, mark 10 years of regular helicopter operation.

News About People

BEAGLE OPERATIONS.—On Jne. 5 Mr. J. M. Nicholson takes up the appointment of manager, flight operations, for the BEAGLE group. He is a graduate of the C.F.S., an ex-Boscombe Down test pilot and since January, 1957, has been chief test pilot of the de Havilland Engine Co., Ltd.

PLANNING POST.—Mr. Richard Willis has been appointed planning manager of Cunard Eagle Airways. He served with P.A.A., B.O.A.C. and B.W.I.A. between 1938 and 1955 and has more recently been directing the activities of the Jamaica Tourist Board in the U.K. and Europe.

R.Ae.S. AWARDS.—Medals and awards recently conferred by the Royal Aeronautical Society are:—Honorary Companionship to Mr. J. N. Toothil; the Society's Silver Medal to Mr. R. Hafner; the Society's Bronze Medal to Mr. L. Haworth; the British Gold Medal for Aeronautics to Dr. S. G. Hooker; the British Silver Medal for Aeronautics to M. Pierre Satre; the Wakefield Gold Medal to Dr. E. Eastwood; the R. P. Alston Medal to Mr. R. P. Dickinson; the N. E. Rowe Medals to Messrs. J. Wilding and W. Bishop; the Alan Marsh Medal to Mr. Jack Brannon; and the Alan Marsh Award to Mr. M. S. Eden.

CASTROL APPOINTMENT.—As one of four new assistant managing directors of Castrol, Ltd., whose appointments take effect on Jan. 1, 1962, Mr. J. A. V. Watson will be concerned with the company's aviation interests. During the War he served with the A.T.A. and in 1942 became its chief test pilot.

AIR BRIDGE APPOINTMENT.—Mr. Alastair Pugh has joined Channel Air Bridge as project and development manager. After taking a four-and-a-half-year course at the de Havilland Technical School, he was on the design staff of H. M. Hobson for three years before joining the editorial staff of *Flight* in June, 1956.

BRISTOL ADMINISTRATOR.—Mr. B. A. Chalmers has been appointed secretary of Bristol Aircraft, Ltd., in succession to Mr. T. B. Pritchard, who continues as financial director.

Mr. J. M. Nicholson, who is to be BEAGLE's manager of flight operations.

BOSCOMBE SUCCESS.—The Aero Golfing Society held their annual match for the Handley Page Cup against the A. and A.E.E. Boscome Down on Saturday, May 13. The result was a win for A. and A.E.E. by 7½ matches to 4½ matches.

Air Transport

Atlantic Licences—The B.O.A.C. Case

THE principal bases of B.O.A.C.'s objection to Cunard Eagle Airways' North Atlantic applications (see last week's issue, pp. 577-8) are that a new U.K. operator's traffic would, almost of necessity, be traffic which would otherwise have been carried by the corporation, and that B.O.A.C. has planned its future fleet and organization to cope with all expected increases in the U.K. share of this traffic.

At last week's continued A.T.L.B. hearings (on the mornings of May 24 and 25) Mr. Basil Smallpeice, managing director of B.O.A.C. filled in some of the figures to supplement an outline of the methods by which future traffic had been forecast by the Corporation. The forecast showed that an average traffic increase of about 17% per annum could be expected between the U.K. and North America, with a total passenger figure of about 1,349,500 in 1966-7—or more than double the present total. Of this, about 895,500 would be the total market for the U.K.-U.S.A. (East)-U.K. services and the British share would be 385,060 passengers. For this, assuming a load factor of 60%, some 674,000 seats would need to be provided.

This share of the U.S.A. (East) traffic assumed a 50-50 U.K.-U.S.A. division after a "cut" of 14% of the total had been taken by other, fifth freedom, operators. With new operators coming in on the route—such as Pakistan International this month and, probably, United Arab Airways in due course—it was fairly certain that there would be no reduction in this percentage of traffic lost to operators who had no direct national interests in the route.

Mr. Smallpeice showed how B.O.A.C. had built up its share of traffic on the North Atlantic routes during and after the years when shortage (or lateness) of adequate equipment had made effective competition difficult. The share of the U.K.-U.S. (East) route traffic had, for instance, dropped to 28.4% in 1956-57 and had been built up to 37.3% in 1959-60, with an average, on all scheduled North Atlantic services, of 41.9% of the total traffic.

B.O.A.C.'s equipment plans were more than adequate to deal with its share of the forecast increases on the routes between now and 1967. There was no reason to suppose that, if U.K. capacity were increased, the U.S.A. would not ask for a reduction in frequencies—and might even propose a modification of the present agreements. In recent congressional testimony, Mr. Alan S. Boyd, chairman of the C.A.B., had said that it was questionable whether the U.S.A. could hold on to the principles of the Bermuda agreement, but had added that his comment was directed to long-range problems rather than to those of the immediate future.

According to B.O.A.C.'s calculations the initial Cunard Eagle plans would involve a total of 147,000 passengers—98,000 of them on the U.K.-New York route. If this traffic were, as must be expected, subtracted from B.O.A.C.'s expectations, then there would be an inevitable surplus of equipment which had been ordered to meet the forecast market. These aircraft had been ordered after consideration of the assurances of Government spokesmen that there would be no impairment of the Corporation's competitive strength.

At the resumed hearing on May 25, Mr. Smallpeice estimated that if Cunard Eagle were to operate a daily round trip to New York, in 1963-64, it would take £5 million gross revenue—equivalent to 25% of the full British share of the whole east coast traffic. Its proposed service to Canada three or four times a week would absorb £2½ million or 29% of the British share.

The licensing of a second British carrier would lead to rights and designation complications. The Canadians would be encouraged to designate a second carrier, probably Canadian Pacific, giving a total of four carriers in a market barely sufficient for two. The Americans would also be likely to designate a third carrier, Seaboard and Western, and to strengthen their demands for traffic rights at B.O.A.C.'s expense in other parts of the World.

Mr. Smallpeice recalled that the 1949 Air Corporations Act required B.O.A.C. to develop routes to the best advantage. The profits of established routes were used to pay for the building up of development routes. Thus, the profits of the eastern routes had paid for the southern routes, and by 1953 the profits of both routes together had enabled the western routes to be built up.

B.O.A.C. had earned the dollar equivalent of £24.8 million in the last financial year.

Answering Mr. N. Ashton Hill, for Cunard Eagle, Mr. Smallpeice said that B.O.A.C. was not required to develop any route specifically: the obligation was general. It could not keep only to profitable routes, nor was it able to pick and choose its routes like the independent companies. There were, however, no routes which B.O.A.C. would hand over to Cunard Eagle to operate. He agreed that it was by coincidence and not by design that Cunard Eagle was applying for the north Atlantic routes at the present time. To the suggestion that the designation of a second British carrier would be an insurance against late delivery of B.O.A.C.'s future aircraft, he said he was confident that Vickers would deliver the VC 10 on time.

The hearing was adjourned until May 30.

A Common-sense View

SPEAKING as guest of honour at the annual dinner of the Canadian Aeronautical Institute on May 25, Mr. B. S. Shenstone, chief engineer of B.E.A., had some characteristically down-to-earth things to say about supersonic transport prospects. A provocative title given to his speech ("The World's Most Dangerous Airline") set the pattern of the views expressed—though the word "dangerous," in this case, was applied more to the financial than to the physical risks taken by the airlines which decided to be the first to operate supersonic transports.

Pointing to the lessons provided by the comparatively short jump into the turbojet era—which caused many airlines to suffer financial set-backs—Mr. Shenstone suggested that the appearance of the SST would force international amalgamations which "could exert complex and difficult travel restrictions of a type hitherto unknown." Such restrictions "could constitute a real danger to the public, who would have to bear not only these limitations but probably higher costs, in fares, resulting from the scramble." The danger was not so much to the lives of the passengers as to the lives of the airlines themselves and to their service to the public.

In Mr. Shenstone's view, after attending the recent IATA Supersonic Symposium, the difficulties now seemed greater than they were before the discussions took place. The 200-m.p.h. jump in cruising speed from the piston to the turbojets had involved major teething troubles, ranging between the disastrous and the merely expensive. Many of the airlines were forced into buying turbojets before they were financially capable of doing so, and even those which had bought the turbojets with the least of teething troubles had been financially embarrassed. History showed that competition from the big airlines might force the smaller airlines to take a chance with the SST which they could not afford.

FIRST FLIGHT.—On May 19, the first production model of the Boeing-Vertol 107 helicopter for New York Airways made its first flight at Morton, Pennsylvania. It is powered by two General Electric T58 turboshaft engines.

Air Transport . . . .

Indo-U.S. Talks Fail

THE failure to reach accord at the recent Indo-U.S. civil aviation talks in Washington, writes a correspondent, is attributed by Indian sources to the refusal of the U.S. authorities to allow additional landing rights to Air-India International. These sources also describe the American attitude as "fantastic."

Air-India International at present operates five Boeing 707 flights a week from Bombay to New York and has planned to operate a daily service next year. The two American carriers operate six services a week through India—four by Pan American World Airways through Delhi and Calcutta and two by Trans World Airlines via Bombay on the New York-Bangkok route.

According to Mr. K. M. Raha, Director-General of Civil Aviation in India, who was a member of the India delegation for the Washington talks, U.S. officials argued that the present volume of U.S.-bound traffic originating in India and India-bound traffic originating in the U.S. did not justify granting more flights to Air-India. If Air-India frequencies were increased, it was feared that traffic lifted by Air-India from third countries would be lost to the U.S. airlines.

Mr. B. R. Patel, general manager of Air-India International, described the American attitude at the talks as "fantastic" and expressed his belief that the U.S. stand was so unreasonable that the American authorities would be forced to reconsider their position. The Americans refused "even to consider" Air-India's request that it might be permitted to operate a daily service to the United States from next April. They took an adamant position that even "consideration of the proposal was impossible." The American attitude appeared to be that there was nothing that India can offer in exchange for a daily frequency for Air-India; in other words India did not germinate enough primary traffic to justify stepping up of the frequency for Air-India.

The Indian delegation wanted daily frequency and if the U.S. was willing to agree to this the American airlines could have 10 or 14 or whatever number of flights a week they wanted, said Mr. Patel. He added: "We were prepared to go further. We would depart from the principle of predetermined frequencies on which we have insisted so far. But we must have daily frequency from next year because we cannot stabilize Air-India's operations in the United States without that."

Mr. Patel said that after the failure of the talks and formal negotiations, some members of the Indian team stayed on for informal talks. It was his individual view that some officials of the American delegation were very unhappy about the position they had to take. His view was that American officials had simply surrendered to the demands of the carriers—even when they were not convinced about the soundness of their arguments.

A Washington report after the conclusion of the talks suggested that the Indian side was responsible for the failure of the talks. It said: "The U.S. carriers felt that there was some discrimination because they were limited to six flights through India each week, compared with a reported 18 flights available to B.O.A.C."

According to legal advisers, Mr. Patel said, there was nothing much the Americans could do short of going back on the existing commitments to prevent Air-India starting a daily service whenever it wished. This was because, unlike Indian permits, the American licence did not stipulate the number of frequencies.

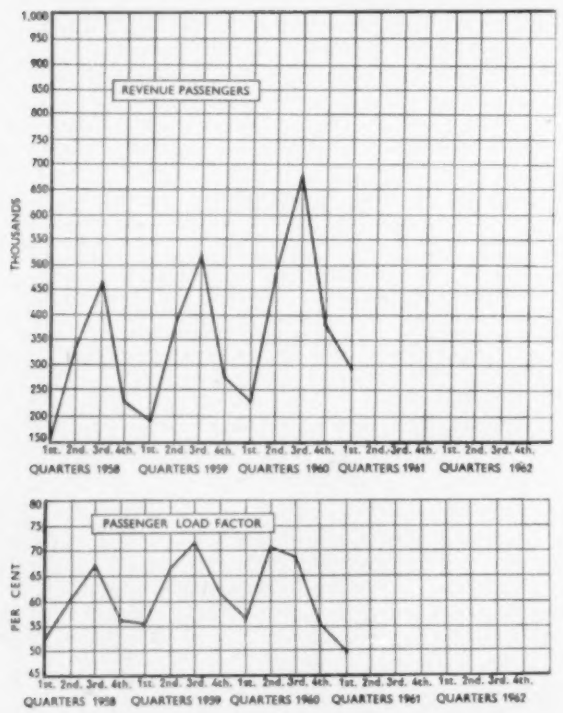
Atlantic Traffic Trends

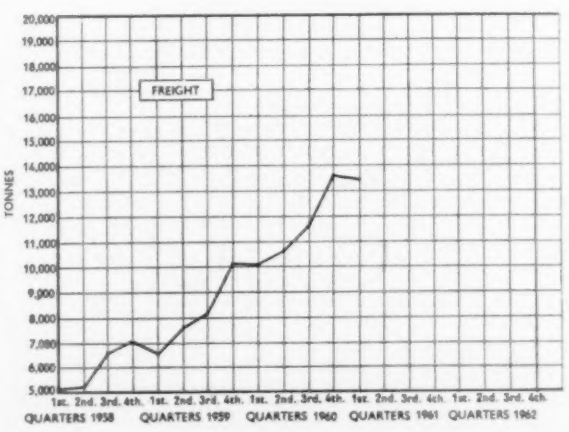
TRAFFIC statistics for the 18 IATA-member airlines on North Atlantic routes in the first quarter of 1961 are tabulated here, and trends are shown in the three graphs. One of the most interesting features of these results is the decrease in average load factor to 49.8%—the lowest for several years. This can, of course, be attributed to the big jump in seats offered—46.9% more than in the first quarter of 1960—as a result of the continued introduction of large jet aircraft. The number of flights increased by only 1.4%.

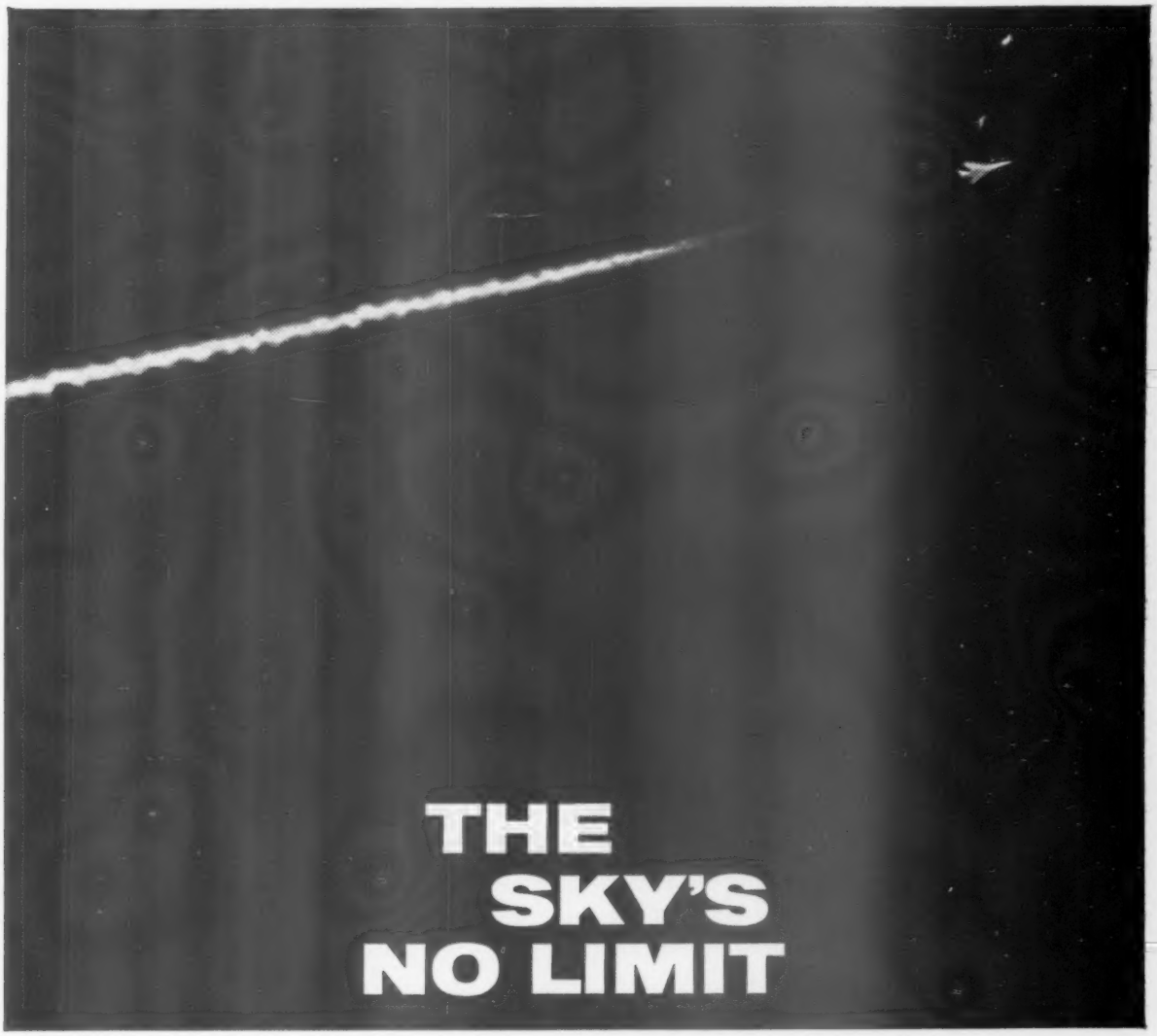
The increase in the number of passengers, at 28.8%, showed a continuation of the rapid growth in Atlantic traffic, which is well above the World average. More than 83% of those who travelled, flew economy class. Scheduled cargo carried during the period increased to a still greater extent, by 34%, and there was a 23% increase in the number of all-cargo flights during the quarter.

FIRST QUARTER 1961

	Eastbound	Westbound	Total	% Change on 1960
Scheduled passenger flights ..	2,558	2,569	5,127	+4.2
Scheduled cargo flights ..	483	470	953	
Seats offered :				
First	66,204	66,235	132,439	—
Economy	227,507	249,728	457,235	—
Total	293,711	315,963	589,674	+46.9
Revenue passengers :				
First	25,175	23,451	48,626	—
Economy	116,048	129,001	245,049	—
Total	141,223	152,452	293,675	+28.8
Passenger load factor (%) :				
First	38.2	35.6	36.7	—
Economy	50.8	55.8	53.6	—
Total	47.9	51.2	49.8	−7.0
Freight (kg.):				
Passenger flights ..	3,778,943	3,378,009	7,156,952	+34.0
Cargo flights	3,635,639	2,703,133	6,338,772	
Mail (kg.)	2,832,958	1,710,739	4,543,697	+45.6







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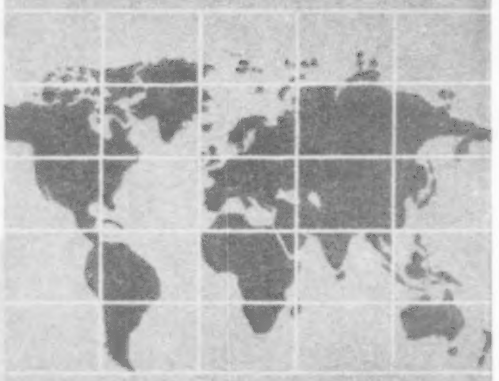

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T.C.A. and the Vanguard

CANADA'S severe winters and high traffic volume represent special conditions for Canadian operators, although Trans-Canada Airlines has dealt with them so long and so effectively that neither is regarded as a problem. Nevertheless, the environment into which T.C.A.'s new Vanguards are settling is different from that of Europe and is therefore worth examining.

T.C.A. is enthusiastic about the Vanguard's performance, particularly on take-off and climb. None of the airfields which the Vanguard is using is small, but T.C.A. expect the take-off performance to be useful as the operation expands to smaller airports. In addition, the short take-off is advantageous when snow or slush is on the ground. The good climb-out not only helps noise abatement but aids air traffic control, particularly at congested terminals like Chicago's Midway and New York's Idlewild. Pilots like the good short-field performance, which is an additional factor in bad weather.

The Vanguard's cruising speed averages about five knots higher than that guaranteed by Vickers, a situation which T.C.A. Vice-president (Operations) H. W. Seagrim describes as "nearly unique." He is also "very enthusiastic" about the let-down speeds, which, at 300 knots, are as high as the DC-8's and "a great time saver." For an aircraft of its size, he thinks the Vanguard has better-than-average flying characteristics.

Trans-Canada's sales promotion of the Vanguard has been so effective that a competitor described it as "superlative." Anyway, passenger reaction has been good, with the large windows contrasting with the tiny ones in today's big jets. Tourist seating is five-abreast (compared with six-abreast in B.E.A.'s Vanguards), so that T.C.A.'s seats are two inches wider than those in its DC-8 tourist compartment. This has caused favourable comment—as has the inside decor.

In order to eliminate combustion heaters—which T.C.A. found troublesome, costly and heavy, it was suggested to Vickers that the aircraft walls be electrically heated. This system takes over from ground heating until the aircraft's compression heating becomes effective. The new system has worked well, and passengers no longer have to stuff blankets between their arm rests and the ice-cold walls as they do in the DC-4M North Stars.

Like any modern aircraft, the Vanguard is going through its usual teething troubles—although T.C.A., as the first operator, is more than usually concerned. Many snags have been overcome. Now T.C.A., Rolls-Royce, Vickers and de Havilland are working jointly on propeller synchronization and synchrophasing in order to reduce noise and vibration.

Two-pilot Operation

Pilots have found it simple to convert to the Vanguard. T.C.A. insists on a month of ground school, 25 hours in the Redifon simulator and 15 hours in flight. The Canadian Air Line Pilots' Association have been promoting the use of a third pilot, but the Department of Transport has agreed with T.C.A. that only two are needed, while upgrading the first officer's standard. An Air Transport licence is now needed, whereas a commercial licence is sufficient on the piston-engined types. So far as the big aircraft are concerned, T.C.A.'s practice is to have pilots fly one type only.

Equipment includes a Collins integrated flight system, RCA AVQ-10 weather radar, with provision in the budget for transponders.

Cold-weather testing was to have been carried out at Churchill, Man., but T.C.A. had so much experience with the Viscount that it was decided that sufficient information could be passed to Vickers without these trials. Canada's winters usually affect aircraft water systems (T.C.A. had to redesign the entire water system of the Super Constellation) and hydraulic seals. Flexible seals between stabilizers and elevators must be kept clean. Freezing rain and wet snow can be troublesome, and vortex generators are a nuisance when cleaning the wings.

T.C.A. is using the Vanguard on stage distances from 150 to about 900 miles domestically, and over somewhat longer stages in the Caribbean. The entire Maritime run can be made without refuelling.

The airstairs save the expense of costly ramps, which at many stops might be utilized for only 40 or 60 minutes a day. T.C.A. hopes to cut its Vanguard stops from 30 to 20 minutes, which will increase the potential utilization of the aircraft by an hour or more a day on routes like those to the Maritimes. By July of this year, 20 of T.C.A.'s 23 Vanguards will be in service, when a daily utilization of 9 hr. 20 min. is planned.

T.C.A. now faces jet competition between Montreal and New York with Eastern's DC-8s and on the Toronto-New York run with American's Boeing 720s. The Viscounts have not yet suffered, probably because of T.C.A.'s superior frequencies and the jets' inconvenient departure times. T.C.A. plans to introduce the Vanguard on both runs soon. On such 300-mile routes its block-to-block time should compare favourably with that of the jets; on the longest stages on which the Vanguard will be used, as in the Caribbean, T.C.A. has no competition. T.C.A. had expected the jets to have a great competitive advantage, but this has not yet proved to be the case on the routes mentioned. By contrast, T.C.A.'s DC-8s have taken considerable traffic from Canadian Pacific's transcontinental Britannias, which earlier had snatched much business from T.C.A.'s Super Constellations.

Good Economics

Lack of competition, until recently, for T.C.A. enabled it to skip the Convairliner and DC-7 stages of re-equipment. Thus it had to decide on North Star and Super Constellation replacements rather earlier than the American airlines. The Vanguard was selected because its economics looked particularly good on the short- and medium-stage lengths on high-density routes. Much of T.C.A.'s traffic is directional and all-cargo services cannot be justified to the Maritimes and to New York and Chicago. The Vanguard carries as much cargo (16,000 lb.) as the all-cargo North Star, whose Toronto-Winnipeg-Vancouver flights will be eliminated this year. Twenty-one North Stars and 11 Super Constellations will be up for sale this year. With their retirement T.C.A. will claim to be the first major airline with an all-turbine fleet.

In Canada all first-class mail goes by air. The Post Office Department likes after-midnight departures from Toronto and Montreal for the West. The Vanguard is ideally suited for this job, for passenger loads on night flights can be limited and the hold can be filled with cargo and mail.

Thus the Vanguard's flexibility won over the Britannia, Electra, DC-9 and Convair 880. The Caravelle was not seriously considered because T.C.A. wanted more than two engines for Canadian winter operations and for the long overwater flights to the West Indies.

Future Fleets

Mr. Seagrim expects the Vanguard to be in service for about five or eight years. As traffic grows it will take over on some Viscount runs, although the Viscounts themselves should last for six or seven years on feeder routes. T.C.A.'s engineering department, which must be one of the most astute in the industry, is constantly studying new aircraft types. Mr. Clayton Glenn devotes his full time to this activity, although many other officials are, of course, concerned.

In line with what it expects to be an industry-wide pattern, T.C.A. is now looking at a short- to medium-range jet for 1964-65 delivery. T.C.A. has in mind an aircraft in the 100-passenger class with a 50 : 50 tourist/first "mix," which would overlap the Vanguard and DC-8. The Vickers VC.11 was favoured, but the project is now understood to be cancelled. The D.H. Trident, Convair 990, Boeing 720B and 727, and Sud-Aviation Caravelle are now under active consideration. T.C.A. has no favourite at the moment, but hopes to make a decision this year.—NEIL A. MACDOUGALL.

The Fighting Services

Reconnaissance Championships

AIRCRAFT and crews of the R.A.F. in Germany played a leading part in the 2nd Allied Tactical Air Force's win over the 4th A.T.A.F. in this year's NATO reconnaissance competition—"Royal Flush Six"—held at the Belgian Air Force base of Beauvechain.

Canberra PR.7s of No. 17 Squadron won the long-range day event, beating U.S.A.F.E. RB-66s of the 10th Tactical Reconnaissance Wing from Alconbury by 2,254 points to 1,942. In the long-range night section No. 31 Squadron, also operating Canberra PR.7s, tied with the U.S.A.F.E. team from the 10th Tactical Reconnaissance Wing with 1,101 points. This was the first time in the six years the contest has been held that two competing teams have finished level.

The third R.A.F. team, from No. 4 Squadron flying Hunter FR.10s was beaten in the short-range section. This was won by the French team with 2,354 points to No. 4 Squadron's 2,226 points. The French won the top individual honours by winning the medium-range missions with a total of 2,421, in addition to their short-range victory.

Overall, the 2nd A.T.A.F. beat the 4th A.T.A.F. by a score of 9,970 points to 9,807 points, their fourth win in this annual contest sponsored by the Allied Air Forces Central Europe (AIRCENT). Last year's competition was won by the 4th A.T.A.F.

The Gruenther Trophy was presented to the Commander of 2nd A.T.A.F., Air Marshal John Grandy, by their Royal Highnesses, Prince Albert and Princess Paola, during special ceremonies at the Belgian base. Individual team trophies were also presented to each of the first-place winners in the four categories—short-range and long-range, day and night. In addition, because of the number of teams competing in the medium-range events, a second-place trophy was presented to the runner-up, the Belgian Air Force, this year's host team, which scored 2,274 points.

During this year's meet, five types of aircraft from eight different nations participated. They were the RF-84F Thunderstreaks of the French, Belgian, Netherlands, German, Norwegian and Danish Air Forces, the Hawker Hunter FR.10s and the Canberra PR.7s of the R.A.F., and the RF-101 Voodoos and the RB-66 Destroyers of the U.S.A.F.E. For the first time a combined team from the Norwegian and Danish Air Forces, representing the Allied Air Forces Northern Europe and a team from the German Air Force took part. These teams participated in the competition under the sponsorship of 2nd A.T.A.F. and 4th A.T.A.F. and were in competition for the team trophy only. They were not competing for the Gruenther Trophy.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Air Ministry: Gp. Capt. J. F. Sandow, O.B.E., M.R.C.S., L.R.C.P., to the Department of the Air Member for Personnel.

Bomber Command: Gp. Capt. D. F. Dennis, D.S.O., D.F.C., A.F.C., to R.A.F. Bassingbourn to command.

Flying Training Command: Sqn. Ldr. W. H. A. Bradshaw, D.F.C., to Headquarters as Command Air Traffic Control Officer, with acting rank of Wg. Cdr.

Technical Training Command: Gp. Capt. P. A. Cooper, M.R.C.S., L.R.C.P., D.T.M. and H., to the Medical Rehabilitation Unit, Headley Court, to command; Gp. Capt. C. E. G. Wickham, M.B., B.S., M.R.C.S., L.R.C.P., D.P. and H., to the Central Medical Board, Central Medical Establishment, as O.C. and President of the Board; Wg. Cdr. J. C. Blair, M.B., Ch.B., to R.A.F. Bridgnorth as Senior Medical Officer; Wg. Cdr. M. D. McCabe, M.B., B.Ch., to the Central Medical Establishment as Senior Medical Officer.

AUSTRALIAN AIR STAFF.—Air Marshal V. E. Hancock, C.B., C.B.E., D.F.C., R.A.A.F., (right) has become Chief of the Australian Air Staff in succession to Air Marshal Sir Frederick Scherger, K.B.E., C.B., D.S.O., A.F.C. Previously A.O.C., Operational Command, Air Marshal Hancock took up his new appointment on May 29.

Near East Air Force (Cyprus): Gp. Capt. B. Sansom, O.B.E., to Headquarters as Senior Technical Staff Officer.

Other Appointments: Gp. Capt. W. D. David, C.B.E., D.F.C., A.F.C., to Air Forces Southern Europe as Chief of the Air Branch, Plans and Operations Division; Wg. Cdr. D. M. Clause, A.F.C., to the U.S.A.F. Base Colorado Springs on exchange posting; Wg. Cdr. R. D. Walton, D.F.C., to Manila as Air Attaché.

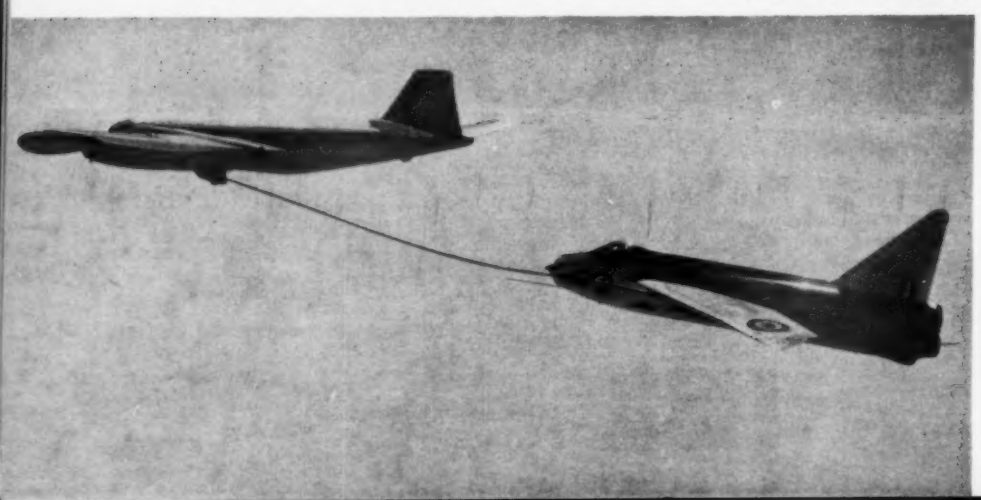
More Service News

Aircrew Swimming.—All home operational R.A.F. Commands are to be represented in a novel swimming event limited to operational aircrew at R.A.F. Cosford on Jly. 26. Suggested by the R.A.F. Swimming Association, this inter-squadron aircrew relay competition includes entries from 36 squadrons.

Canadian Award.—Sqn. Ldr. J. A. G. F. Villeneuve, leader of the R.C.A.F. Golden Hawks aerobatic team, has been awarded the Air Force Cross for his "skill, courage and determination" in bringing his Sabre in for a forced landing rather than allow it to crash in a populated area.

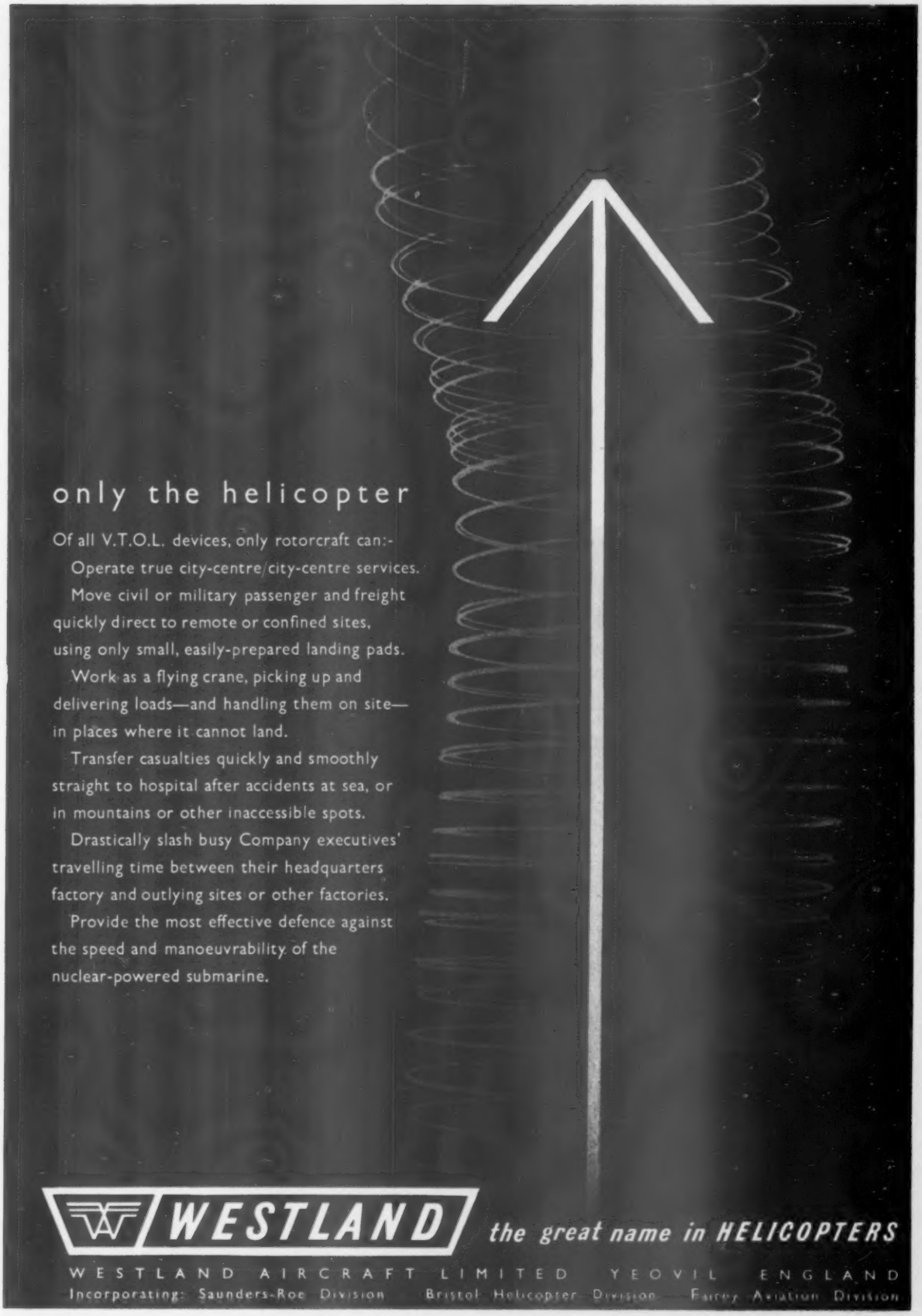
Vancouver Tattoo.—The R.A.F. Touring Physical Training Display Team is to appear in the Vancouver Searchlight Tattoo in Canada in July. Led by Flt. Lt. A. L. Ford, the 36-man team will fly to Canada by Transport Command Britannia at the end of this month.

R.C.N. Appointment.—Cdr. V. Wilgress, R.C.N., has succeeded Capt. C. Edwards, R.C.N., as Director of Canadian Naval Aircraft Requirements with the rank of Captain.



R.A.A.F. IROQUOIS.—Above, the delivery of eight Bell 204B helicopters (U.S. Army HU-1B Iroquois) to No. 9 (Search and Rescue) Squadron, R.A.A.F., is expected to be completed before the end of next year. Here a HU-1B, powered by a Lycoming T53-L-9 turbine, is seen in Australian markings.

LIGHTNING REFUELLING.—In-flight refuelling trials with the Lightning are being undertaken by English Electric from Warton. Here a production F.1 is seen linked up with a Canberra tanker.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Manufacturing licence agreements for the Orpheus have been signed with France, Italy, India and Germany, and for the Viper with France and Italy.

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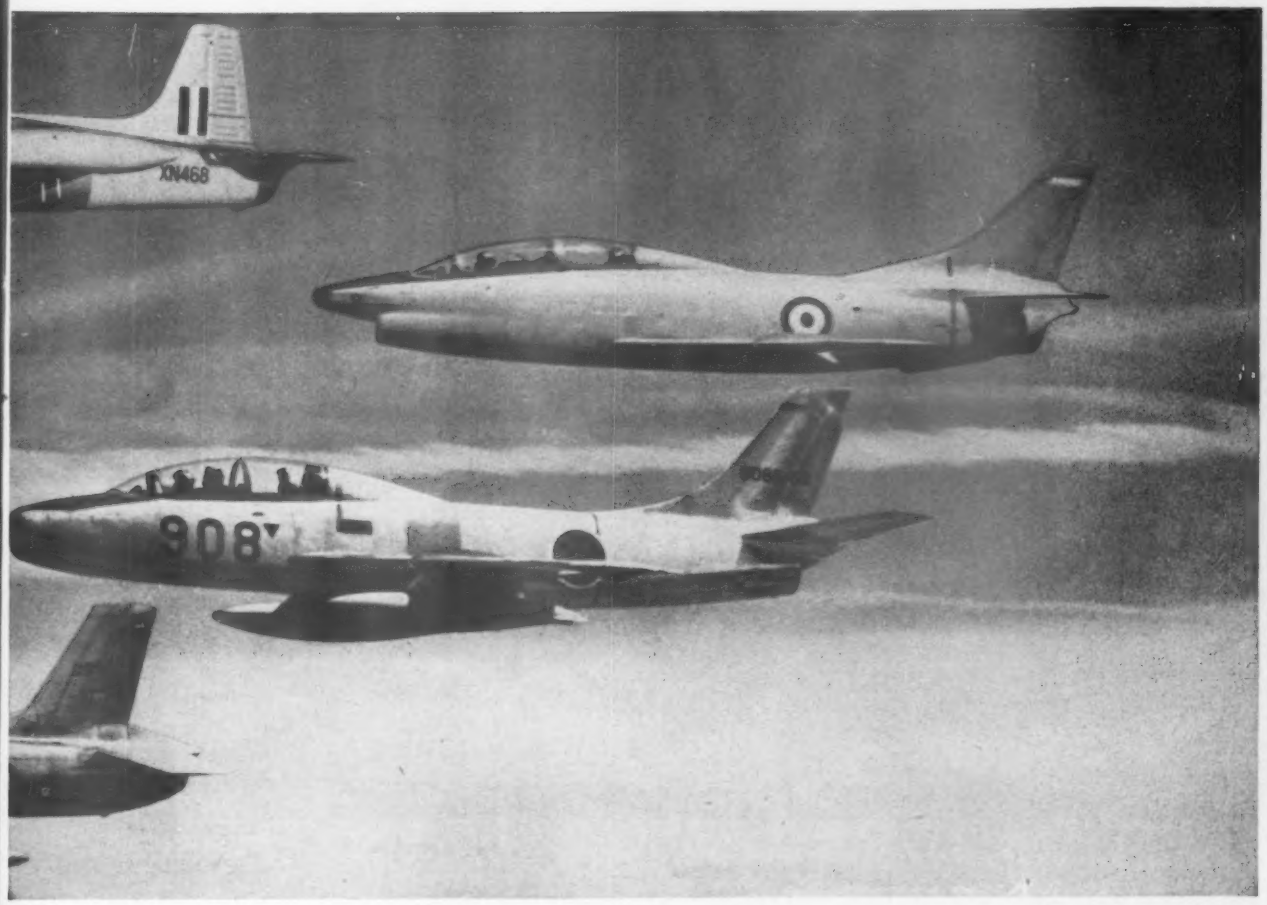
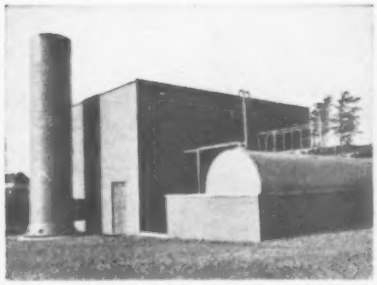


FROM L TO R: FOLLAND GNAT TRAINER — MACCHI MB 326 — HUNTING JET PROVOST TRAINER — RUSH TIP-2 — FIAT G 91T

forces of 5 countries . . .

SUPPLY THE POWER



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The Bristol Siddeley Industrial Proteus gas turbine engine powers a 3,000-kilowatt turbo-generator. Designed for peak-lopping and stand-by generation, this new pocket power station, two of which are in service, delivers full power within 2 minutes of a cold start for a lower capital cost than any other comparable type of installation.

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Bristol Siddeley Maybach diesel engines power Britain's crack express train—the British Railways "Bristolian". Two Type MD 650 engines, developing a total 2,200 hp, give the "Bristolian" a top speed of 90 mph. 286 Bristol Siddeley Maybach diesels have been ordered by British Railways alone.

. . . AND THIS

The Bristol Siddeley Pegasus lift/thrust turbofan powers the Hawker P 1127 strike aircraft—the world's first VTOL jet aircraft designed for operational service. Thrust is applied through four movable nozzles evenly disposed around the centre of gravity, providing a single power source for all conditions of flight.

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Flying the Beech Queen Air

by John Fricker

BEECH'S Model 65, appropriately named Queen Air, brings to a very advanced stage the American concept of a miniature airliner for executive flying. Such features as built-in air-stairs, rear toilet compartment and separate crew accommodation—which are standard items—plus provision for weather radar, lightweight de-icing, stand-by JATO rockets and other optional installations, distinguish the Queen Air from many lesser competitors in its class. Its geared, supercharged and fuel-injected 340-b.h.p. Lycoming IGSO-480-A1B6 engines confer an economical cruise performance of more than 200 m.p.h., and a service ceiling above 30,000 ft., while completely equipped, it can carry six people and their baggage over 1,000 miles non-stop in little more than five hours, with 45 minutes' reserve.

More than 100 Queen Airs have been built since production started last year, and the first for a U.K. operator was delivered to the British Oxygen Company for executive use during the recent Shackleton sales week-end at Baginton. Short Bros. and Harland, Ltd., Beech distributors for U.K. and Eire, also showed their Queen Air demonstrator, G-ARFF, which was made available for a prolonged evaluation flight. Weather was poor, but provided an opportunity of assessing what proved to be the very good instrument handling qualities of the Queen Air.

Structurally, the Beech range was analysed in detail in our issue of May 18, and a quick pre-flight walk-round G-ARFF at Baginton provided a confirmatory impression of the above-average load factors of the all-metal airframe. According to the book, its "structural integrity is proven in excess of the 6.6 *g* load required for a utility class certificate" and this despite extensive use of fluted skin covering for control surfaces, tail group and slotted flaps, with a minimum of internal structure.

Ailerons and elevator have anti-servo and trimming tabs, while the rudder has a conventional servo inset. The latter works in the opposite sense to the anti-servo tabs in decreasing slightly the effective control area, but reducing the rudder pedal loads, particularly for asymmetric flight. The closely cowled Lycomings use twin exhaust ejector tubes and drive three-bladed Hartzell constant-speed and feathering propellers.

The built-in air-stairs largely cancel out the disadvantages of the low-wing layout for easy cabin access, for a very small weight penalty. To the right as one enters the spacious and

luxuriously appointed cabin is the cloakroom and baggage area (30 cu. ft., 300 lb. capacity) where two additional seats may alternatively be installed.

Accommodation is otherwise provided for five passengers alongside the panoramic windows, in individual reclining seats, or, for non-British-registered aircraft, two seats and a divan to starboard. At the moment, A.R.B. will not approve the occupation of sideways-facing seats by passengers during take-off and landing.

With its twin sliding doors to seal it off from the cabin, the flight deck is roomy and comfortable. The sliding and reclining pilots' seats are separated by about 18 in. for easy access, and with their folding arm rests, are among the most restful I have encountered in an aircraft of this size. Control and instrument layout is equally well-planned, and since the front panel is coloured to complement the aircraft's external paint scheme, it provides a welcome change of pastel finishes to flank the central nav./com. radio area.

Beech have gone to a lot of trouble to satisfy the all-important individual choice of radio, as well as instruments, to customers' requirements, while keeping within a number of standardized layouts. In standard form, the Queen Air is delivered with a single full flight panel on the port side, with engine instruments over the radio group, but there are two alternative de luxe front panels available or an integrated flight system may be incorporated.

Radio-wise, even more diversity is available. Five standard packages are offered from different manufacturers, comprising ARC, Bendix, Collins, Dare and Wilcox and ranging in weight from 78 to 104 lb., in that order. Prices vary from $11,860 for the Dare installation, to $18,950 for the Collins. De luxe radio packages for all-weather flying are also offered from the first four manufacturers, ranging from the 181-lb. $23,990 Dare installation to the 176-lb. $34,490 Collins equipment.

Combinations of the various items in the packages permit an infinite variety, to which can be added, if required, RCA AVQ-50 or Collins WP-103 weather radar, for a weight penalty of about 90 lb., and an additional $12,300 or $16,520. Motorola, Lear or Sperry autopilots can add $6,600-$8,650 and up to 80 lb. to the basic Queen Air. With many of these optional items, including weather radar, the Wilcox/Collins radio package with HF, ADF, twin VHF, VOR, ILS, plus de-icing and auto-pilot, G-ARFF weighs in at 5,432 lb., compared with the normal empty weight of 4,740 lb.

Despite its size and efficiency, the Queen Air is designed very much with the "fly-yourself" executive in mind. This is apparent from the functional arrangement of the cockpit and such items as the fuel control panel, which is laid out diagrammatically on the left of the first pilot's seat.

The fuel panel incorporates selectors, cross-feed valves, booster pump switches and gauges for the tank system, which

The British Oxygen Queen Air, shown in these two photographs, is one of the latest production examples, incorporating a few modifications, mainly in panel layout. On the deep and roomy instrument panel, surmounted by a padded coaming, is adequate space for two full sets of flight instruments, if required, plus a weather radar scope in the central radio group.

Photographs copyright "The Aeroplane and Astronautics"

in standard form comprises a 36.6 Imp. gal. and a 38.3 Imp. gal. cell in each wing, or just on 150 Imp. gal. Optional auxiliary wing tanks, of 20.8 Imp. gal. per side, may be installed for an additional $2,800, to bring the total capacity to 191.4 Imp. gal. For fuel management purposes, the standard outer tanks and optional cells are then grouped together as auxiliary tanks, with rather more capacity than the inner cell in each wing.

Nearly full fuel was carried at the start of our two-hour evaluation flight, which was under the supervision of Ken Dunlop, Short Bros. staff pilot, in the right-hand seat. He coaxed the Lycomings into life, which in G-ARFF is a bit of a three-handed operation, although later Queen Airs, including the B.O.C. executive G-ARII, have combined ignition, start and prime rotary switches. Priming is achieved by pressing their centre buttons while turning them to "start."

The large cockpit windows and high seating position of the pilots give an excellent view, and ground control with the powerful toe brakes and rudder-pedal operated nosewheel steering proved extremely good for the tortuous taxi-ing at Baginton. The nosewheel steers 14° left and 12° right, and castors for tighter turns with brake and/or differential engine. Despite its sophistication, the Queen Air did not seem to dislike operation from grass, on which its oleos rode smoothly and softly, although the initial take-off, made by another pilot, was from Baginton's new runway.

Pre-flight settings of the well-arranged trim wheels on the small central quadrant were neutral, or slightly nose-up for the elevator for our loading. The only possible criticism of the trim controls could be that the lateral and directional wheels and adjacent indicators are obscured somewhat by the selector console of the Lear autopilot. All services are electrically operated, and 40% flap was selected by the three-position lever on the panel, for take-off. Maximum flap extension—100% on the gauge—is only 30°, although flap area is fairly large.

Take-off technique is entirely conventional for an American aircraft, with excellent directional control from nosewheel steering and no tendency to swing. Some care is needed, however, to avoid overboosting on opening the throttles. Max. sea level boost is 48 in. Hg, which is achieved by opening up to about 45 in. on the manifold pressure gauge at the start of the take-off run.

Power to Spare

Acceleration, plus the automatic change from filter to ram air, with an appropriate indication from panel lights as the landing gear is retracted, adds at least 2 in. Hg boost during take-off. A throttle gate with a variable datum would be a useful refinement, particularly since inadvertent overboosting during an overshoot results in a tendency for the engines to misfire.

With the Lycomings delivering their maximum power at 3,400 r.p.m., take-off acceleration is pleasantly brisk, and V_{mc} of 95 m.p.h. is reached within seconds of the normal 80 m.p.h. unstick. The Queen Air is at 50 ft. within 500 yd., and best angle of climb, safety and best single-engine climb speeds of 101, 105 and 117 m.p.h. follow in rapid succession. Cruise climb speed is as high as 160 m.p.h. at 85% power of 39 in. and 3,000 r.p.m., and gives a stimulating foretaste of Queen Air cross-country performance.

Undercarriage retraction occupies about seven seconds and flaps about four from the take-off setting. Both operations are accompanied by a slight nose-up trim change, the out-of-trim forces being remarkably small at all times. In extensive tests to check the Beech brochure figures, Shorts have found these unusually accurate. One of the biggest discrepancies was the initial rate of climb, quoted at 1,235 ft./min. and found to be 1,473 ft./min. at 7,700 lb. gross for G-ARFF.

Although the Queen Air can get to 32,700 ft., and has a single-engine service ceiling of 15,500 ft., we were content with three or four thousand feet for our local flying from Baginton, just above one layer of cloud which merged almost indistinguishably into complete cover above. With the ADF tuned unmistakably to Daventry, and the voices of the harassed Coventry controllers coming loud and clear through the cabin speakers above the muted hum of the Lycomings, we settled down at 32 in. Hg and 2,750 r.p.m. (60-65% power) to indicate a leisurely 180 m.p.h.

T.A.S. at similar r.p.m. and 31.5 in. Hg at 10,000 ft. was found to be 203 m.p.h. during Short's test. Fuel consumption was then 32 Imp. gal./hr., giving an a.m.p.g. of 6.4. Mixture control of the fuel-injected Lycomings is automatic.

Seated behind the left-hand low-slung ram's-horn control wheel, I found that both seat and rudder pedals were adjustable for additional comfort. Control forces and co-ordination were such that a completely effortless impression of flight was quickly obtained, a fine balance being achieved between response and degree of control displacement.

Good lateral control is perhaps the first thing one looks for in most aircraft, and in the Queen Air the ailerons set the tone as the lightest of the group. Rudder and elevators follow on in that order, and are allied to the normal stability pattern for an aircraft of this class. Longitudinally, a little difficulty was experienced in trimming out G-ARFF to hold a precise speed, stick-free, although this may have been complicated by a perceptible amount of static friction in the elevator circuit.

The effective combination of stability and control, however, makes it a simple matter to maintain any selected flight path on instruments, and aileron alone is adequate for all normal turns. The qualities of the Queen Air are such that one of the pilots on board for his first flight had no hesitation in taking G-ARFF down to its minimum control speed of 95 m.p.h. on instruments, in cloud, with one Lycoming feathered, at about 1,200 ft.

I first tried asymmetric flight with one engine set to deliver zero thrust, but handling was not representative until the powerplant had been feathered, when the foot load and nose-down trim change immediately reduced to low values. With the live (port) engine at 40 in. Hg and 2,700 r.p.m., speed fell gently to 135 m.p.h., and a fair amount of cranking on the low-geared rudder trim cancelled the remaining foot load. Take-off power on one, and reducing speed to 110 m.p.h. resulted in an indicated climb of about 400 ft./min., and there was just enough directional trim left to cope with the asymmetry.

Short's own V_{mca} checks, which involved cutting an engine at safety speed (105 m.p.h.) and minimum control speed (95 m.p.h.), resulted in each case of only 5° angle of bank and change in heading being obtained with no loss of height, and estimated pedal forces of 50 and 70 lb., respectively. Turns in each direction on asymmetric power are completely uneventful, and the rate of roll remains at about 30°/sec. down to the minimum control speed.

In the clean configuration, this also coincides fairly closely with the normal stall breakaway, which is heralded by a slight buffet at about 100 m.p.h. and indication from the stall warning light and horn. At just over 90 m.p.h., I.A.S., with a fair heave maintained on the wheel, the nose dropped gently with about 100 ft. height loss, although the Queen Air could be flown with care down to 85 m.p.h. before an innocuous breakaway.

It refused to be provoked into *g*-stalling by snatching back the wheel at about 100 m.p.h., contenting itself with a protesting judder giving unusually good aerodynamic warning. Lateral and directional control remained up to the breakaway, just prior to which G-ARFF was indicating about 1,000 ft./min. descent on the V.S.I.

This high rate of sink at low speeds is characteristic of many American aircraft with barely perceptible stall characteristics. In the "all-down" configuration, full aft elevator could be achieved in the Queen Air, in and out of buffet at around 82-84 m.p.h., with no firm nose-down pitch apparent at all.

Because of the small nose-down change in trim on lowering undercarriage and flaps, below their limit speeds of 150 m.p.h., the tendency for the nose to rise on adding full power from the approach configuration is also pleasantly slight. This was particularly appreciated when I was forced to overshoot twice, after returning to Baginton, because of the congestion of aircraft on the grass landing area. Apart from the necessity to avoid over-boosting, the climb-away from a baulked landing was simple and positive, even from final full-flap speeds of less than 100 m.p.h.

In the circuit, the Queen Air maintained its docility, and motoring in on finals at just on 110 m.p.h. gave adequate elevator response for a hold-off and touch-down at slightly more than 90 m.p.h. The nosewheel could be held off, if required, or lowered and the flaps retracted for optimum braking. This was not needed on Coventry's relatively short grass strip, the Queen Air handling like a light aeroplane, while performing in the 200 m.p.h.-plus bracket.

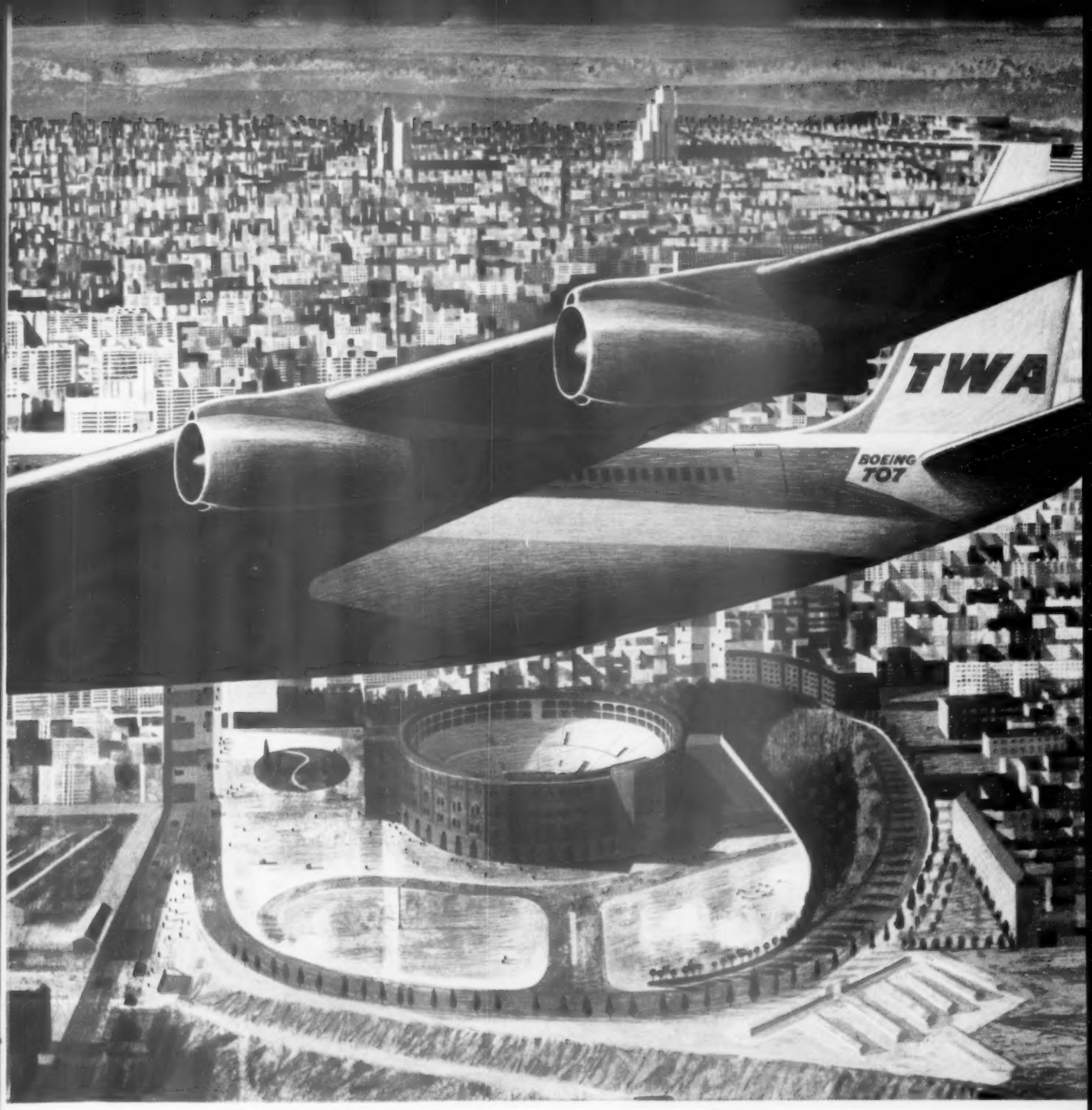
I brought G-ARFF back to its parking place with the feeling that it was as nice an aeroplane as I had ever flown, and its performance, handling, structural and accommodation qualities fully justified its $126,000 (£54,630 U.K.-delivered and duty paid) basic price tag. The old adage of getting what you pay for was never so true as in the aeronautical field, and there is no doubt that the Queen Air is right at the top of its class.

Leading Particulars

Dimensions.—Span, 45 ft. 10½ in.; length, 33 ft. 4 in.; height, 14 ft. 2 in.; wing area, 277.06 sq. ft.

Weights.—Empty, 4,740 lb.; equipped, 5,432 lb.; available for passengers, baggage and optional equipment, standard tanks full, 1,880 lb.; max. landing, 7,350 lb.; max. take-off, 7,700 lb.

Performance.—Max. level speed, 12,000 ft., 239 m.p.h.; never-exceed speed, 270 m.p.h.; cruising speed, 10,000 ft., 70% power, 205 m.p.h., 65% power, 200 m.p.h., 45% power, 166 m.p.h.; range, with full reserves, standard fuel, 10,000 ft., 70% power, 760 miles, 65% power, 780 miles, 45% power, 910 miles; initial climb, 1,300 ft./min.; single-engine climb, sea level, max. gross weight, 245 ft./min.; service ceiling, 31,300 ft.; asymmetric service ceiling, 15,500 ft.; stalling speed, all-down, 80 m.p.h.; take-off run, 20° flap, 1,180 ft.; to 50 ft., 1,560 ft.; landing run, full flap, 1,280 ft.; from 50 ft., 1,685 ft.; max. endurance, standard fuel, 8.5 hr.



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THE BIGGEST INTERNATIONAL AIR SHOW

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BALLISTIC BUGGY.—Symbolic of the massive U.S. participation in the 1961 Salon—Cdr. Shepard's Mercury space capsule "Freedom 7."

FOUR principal features characterize this year's Salon International de l'Aéronautique—the 24th of the series—which reaches its usual climactic conclusion this week-end with Sunday's marathon flying display.

The show is more completely international in character than ever before; the United States' contribution is significantly immense; space programmes rather than "deterrent" developments are the dominating themes for individual and national exhibitors in missile and associated fields; and, finally and simply, the indoor exhibition is physically about twice the size of that for the previous show in 1959.

A decade or so ago the Salon, then in the Grand Palais, was essentially a shop window for the French aircraft industry, with other exhibitors (mainly British) providing only a comparatively minor contribution; now the "foreign" exhibitors tend almost to dominate the inside and outside displays at Le Bourget.

With the regrouping, since 1959, in our own industry, and the consequently increased size of fewer stands with a greater diversity of exhibits, the British contribution probably has a much more effective impact than in previous years. Nevertheless while, no doubt, admiring the British, American and other contributions, the mass of the visitors at the show were obviously immensely proud of their own industry and one could hardly walk along for more than a minute without hearing the words "Sud" or "Caravelle."

The importance of the show to America was symbolized by the last-minute arrival of the actual Mercury capsule, "Freedom 7," in which Cdr. Shepard made his sub-orbital test "flight." It was given no particular prominence—and, on its arrival on the pre-view day, merely took its place among the assorted exhibits in the "geodetic tent" where representative American space and associated activities are being demonstrated. But the fact that the capsule was shown, complete with its instrumentation and controls (and a dummy astronaut looking about as uncomfortable as any human might be expected to look), must inevitably impress everyone—and especially the Russians.

A more immediately practical demonstration of full and serious U.S. participation was the supersonic, air-refuelled transatlantic flight (in 3 hr. 19 min. 41 sec. from overhead New York) of the Convair B-58 Hustler. After its landing at Le Bourget on May 26 the B-58 also took a relatively modest position in echelon beside the Russian Tu-114 turboprop transport in the aircraft park—where it served to complete an already extremely impressive American military display of aircraft.

In this park there were examples of the very newest and most technically and aerodynamically exotic of U.S. combat and other aircraft. Two of them—the North American Vigilante and the McDonnell Phantom 2—came from the U.S. Naval Air Test Center; others, including a Crusader 2, a Skyray, a Skyhawk and a Demon, were from the U.S.S. "Forrestal" of the U.S.N. Sixth Fleet in the Mediterranean; and the Republic F-105D Thunderchief was one of the first dozen now in service with the U.S.A.F. in Germany as replacements for the F-100s. Both the Vigilante and the Phantom 2 are World-record holders—the former for altitude and the latter for closed-circuit speed.

By comparison the British military contribution in the park may seem to be a trifle pedestrian—but the balance will be at least partly restored this week with the show by the Lightnings of No. 74 Squadron and by the arrival of Naval aircraft from H.M.S. "Hermes."

The 1959 show at Le Bourget was notable for its "Manhattan skyline" of missiles. This year there are no such things to be seen from the U.S. and those in the area devoted to "fusées" were British and French devices of, perhaps, a more immediately useful kind, but of a less physically impressive nature. Except for a few models here and there, the U.S. missiles have been replaced by space vehicles—actual or futuristic.

Characteristically—and despite the great weight of military and transport emphasis—the outside show is predominantly one of light and executive aircraft and helicopters. There are well over 60 different types on display and many of them have been demonstrated day by day throughout the show period—sharing the sky with the routine Le Bourget airline traffic, or cavorting fairly freely in a block of airspace at the southern end of the field.

Last week-end old-timers among the visitors will have been duly delighted by the polished aerobatic performance, in classic style, of four old Stampe biplanes—three in formation and one individual—of the Patrouille de St. Yan, while more sophisticated modern aircraft continued, elsewhere at Le Bourget, to blast their way periodically into the sky.—H.A.T.

Paris Show Report . . . .

The First Week-end—Aircraft on View

COMMERCIAL AND EXECUTIVE

DURING the first two days at Le Bourget the civil aircraft picture had still to be developed so far as real-life exhibits were concerned. Mock-ups, "half" mock-ups and models there were in plenty, but the only specifically new transport aeroplane to be seen was the four-Astazou Potez 840 which had made its initial flight only a few weeks before. The interest lay mainly, therefore, in the changing emphasis within the French aircraft industry, in the smaller aircraft and, particularly, in the massive application of small turbine engines to a variety of aircraft types.

At about noon on the preview day, Thursday, the General Electric Caravelle III, "Santa Maria," with its CJ-805-23 turbofans, flew in from the U.S.A. (though it was not exhibited, at least initially, in the exhibition aircraft park) and on the following day the first of the Russian aircraft, the monumental Tu-114 turboprop, arrived after, apparently, something of a struggle with ATC in the conditions of deep overcast and heavy rain. The turbofan-engined Tu-124, the An-10 and the An-24 had still to appear and no one was really quite certain whether one or more would be coming before the end of the week. The G.E. Caravelle was notable for the unexpected diameter of the annular fan intakes at the rear of the power-plants. The Tu-114 had not, in fact, been initially expected. New to the Show amongst bigger civil aircraft is the Grumman Gulfstream executive, and new to Europe is the North American Sabreliner, which, though essentially a U.S.A.F. aircraft, has some interest for the advanced potential executive owner. The Max Holste Super Broussard is also being seen at the Show for the first time in its turboprop-powered form.

Until almost the eve of the opening of the exhibition it had been hoped that the Breguet 941 would have made its first flight in time to be shown. As this page went to press the first flight of this very significant slipstream-lift STOL aircraft was still "imminent" and it seemed just possible that it might be able to make an airborne appearance during the final days' displays. It was rolled out at Toulouse on Apr. 23; but, notwithstanding the great amount of test-rig and other preliminary work, a project of this kind is not one which, involving such relatively new high-lift concepts, could quickly be taken through its preliminary trials.

The 941, a military transport variant in the "94" series, will be followed in due course by the 942, which is to be "civilianized" and will have a pressurized fuselage. Later, there will be civil and military variants with two, instead of four, Turmos, which will be coupled to four propellers. Full-scale fuselage mock-ups of the 941 and 942 are to be seen in the aircraft park. The first, with its full-width rear-loading door, is shown with appropriate military loads, while the second is in passenger form with Air Inter (French domestic airline) markings.

Seen at the Show two years ago in its piston-engined form, the Max Holste 260 Super Broussard is, with its two Bastan turboprops, effectively a new transport aircraft so far as the 1961 exhibition is concerned. This aircraft, the first prototype, made its initial flight in July last year and is shown at Paris in the colours of Royal Air Maroc, which has three of the type on order.

The French Government has financed the production of 100 Super Broussards and the MH.260, or its pressurized passenger variant the 262, is on order or on firm option by, amongst others, Ansett-ANA of Australia (262) and New Zealand National Airways. The 262 will have a large forward freight door and the 261, a military variant, will have rear loading. As shown at Paris, the 260 is laid out for 14 passengers.

Seen in mock-up form is the Broussard Major, which with two 315-b.h.p. Lycomings, will carry up to seven passengers with a single pilot. Metal is now being cut on the prototype and the first flight is scheduled for next year.

The Potez 840 (see our issue of Mar. 23, 1961, p. 315) is the first aircraft to have been designed specifically around the Astazou turboprop. Two prototypes of this attractive little four-engined 16/24-passenger civil/military transport are to be built. It remains to be seen whether potential purchasers will be prepared to accept the additional costs involved in a four-turboprop arrangement for an aircraft of this size.

The Astazou is to be seen in several variants of light and executive aircraft. Apart from the Pilatus Porter, which has been re-engined with this effective and easily controlled turboprop, there is the SFERMA Marquis, a twin-Astazou redevelopment based on the Beechcraft Baron, and a Do.27 was due to be seen with this engine, which is to be used by the SIPA 272 twin-engined Présence, shown at Le Bourget in mock-up and model forms.

The Marcel Dassault 415 Communauté, seen for the first time at Paris in 1959, and its 410 Spirale variant, appear now to have no further prospects except in relation to the proposed Dassault-Sud Spirale III. This, shown in the indoor exhibition as a fuselage mock-up, is a high-wing military freighter with rear loading doors. The twin-Bastan Spirale was itself shown in the aircraft park.

Trends in turbojet executive development are seen in the Potez-Heinkel CM 191 and in the Morane-Saulnier 760C Paris

(*Continued on page 621*)

All kinds of aircraft occupy the static aircraft park at Le Bourget—among them here, during the opening week-end, can be seen part of the extensive British contribution to the Show: a Vulcan, Victor, Britannia and Argosy. A new and dominant feature of this year's Paris Salon are the outside pavilions "à la Farnborough."

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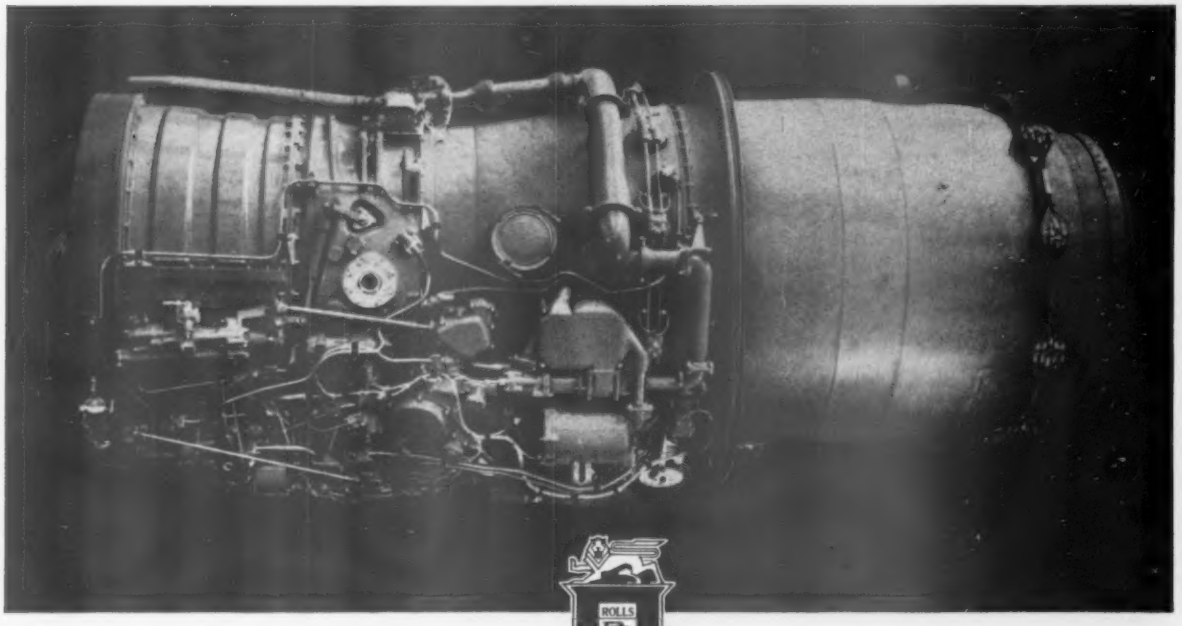

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The Potez 840 (see our issue of Mar. 23, 1961, p. 315) is the first aircraft to have been designed specifically around the Astazou turboprop. Two prototypes of this attractive little four-engined 16/24-passenger civil/military transport are to be built. It remains to be seen whether potential purchasers will be prepared to accept the additional costs involved in a four-turboprop arrangement for an aircraft of this size.

The Astazou is to be seen in several variants of light and executive aircraft. Apart from the Pilatus Porter, which has been re-engined with this effective and easily controlled turboprop, there is the SFERMA Marquis, a twin-Astazou redevelopment based on the Beechcraft Baron, and a Do.27 was due to be seen with this engine, which is to be used by the SIPA 272 twin-engined Présence, shown at Le Bourget in mock-up and model forms.

The Marcel Dassault 415 Communauté, seen for the first time at Paris in 1959, and its 410 Spirale variant, appear now to have no further prospects except in relation to the proposed Dassault-Sud Spirale III. This, shown in the indoor exhibition as a fuselage mock-up, is a high-wing military freighter with rear loading doors. The twin-Bastan Spirale was itself shown in the aircraft park.

Trends in turbojet executive development are seen in the Potez-Heinkel CM 191 and in the Morane-Saulnier 760C Paris

(*Continued on page 621*)

All kinds of aircraft occupy the static aircraft park at Le Bourget—among them here, during the opening week-end, can be seen part of the extensive British contribution to the Show: a Vulcan, Victor, Britannia and Argosy. A new and dominant feature of this year's Paris Salon are the outside pavilions "à la Farnborough."

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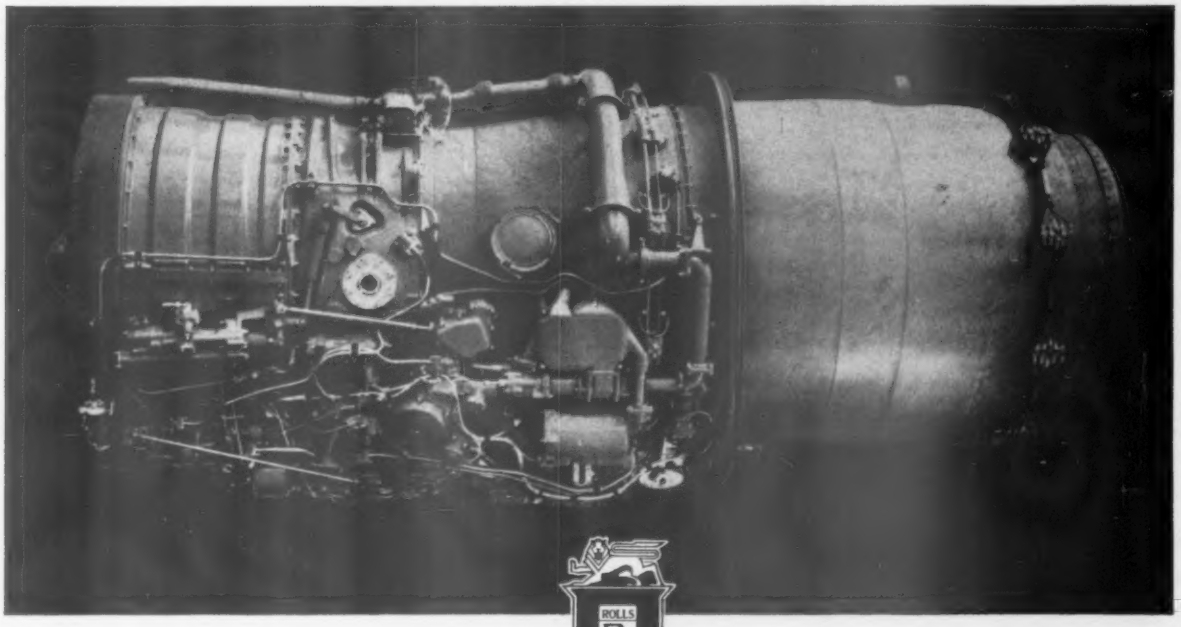
ROLLS-ROYCE SPEY



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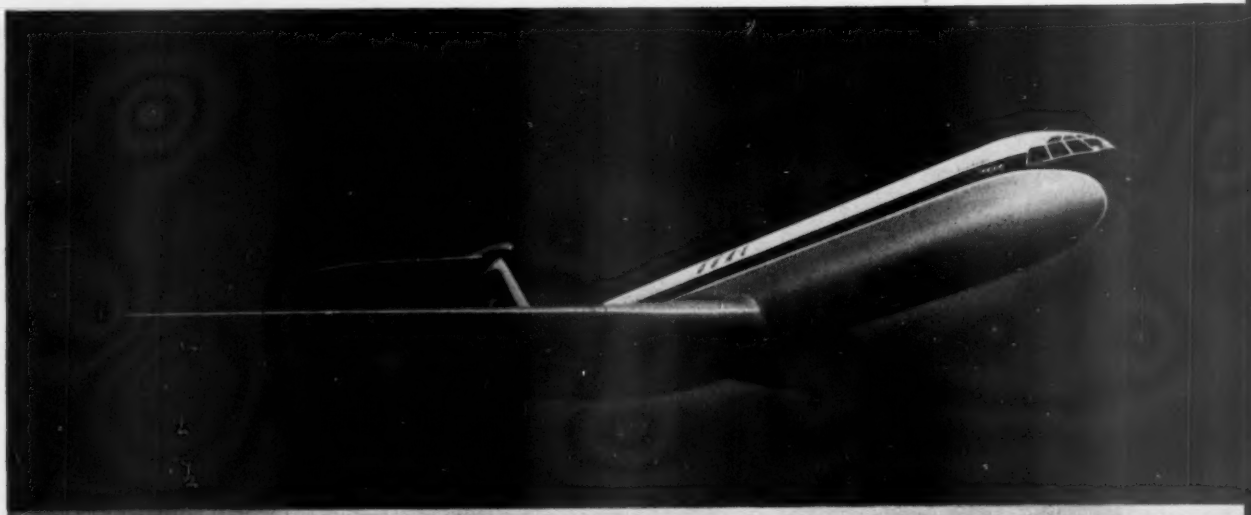

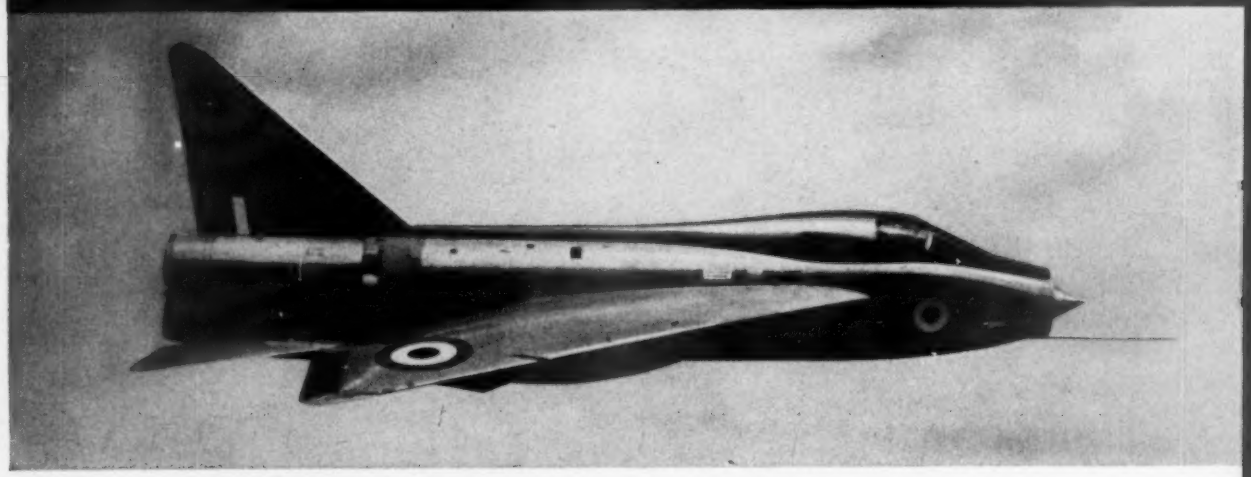

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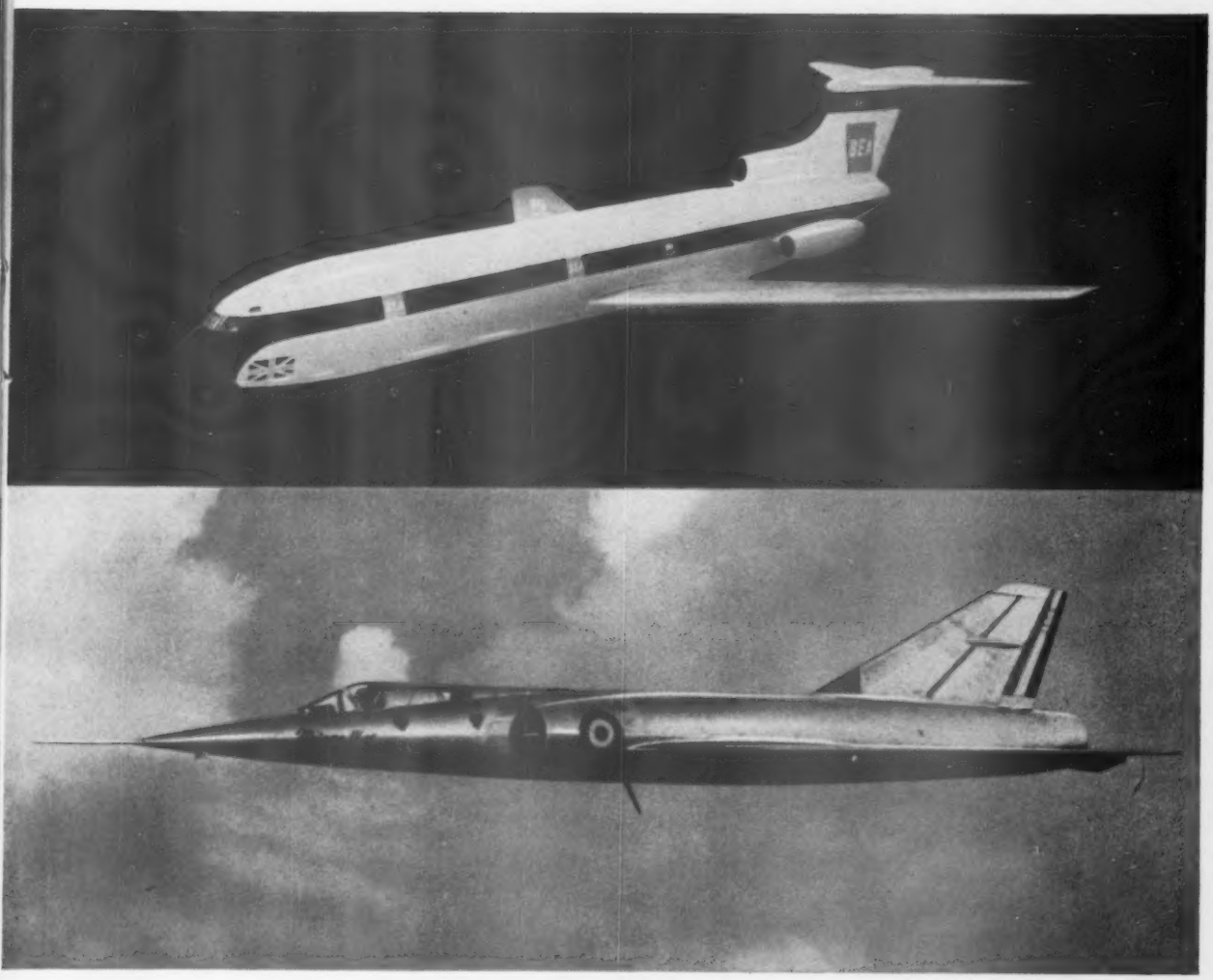

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AIRCRAFT AT HOME AND ABROAD

6/3706

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BRITISH EUROPEAN AIRWAYS

Paris Show Report . . . .

NEW VERSION.—The Morane Saulnier Paris III, shown in "half" mock-up form, differs from the Paris II, seen previously, in having a five-seat cabin with large entry door in place of a lifting canopy.

(*Continued from page 620*)

III—each of them powered by two Marboré VIs. The first—a finished aircraft shown effectively in the indoor exhibition—is built by Heinkel as a co-operative venture with Potez-Air Fouga. It is a development of the CM 170 Magister in which the two-seat military trainer has become a four-seat executive, or command, aircraft. The Paris III, shown as a "half" mock-up, differs from the canopied Paris II in having a conventionally enclosed five-seat cabin with a large entry door on the port side.—H.A.T.

MILITARY AIRCRAFT

In the military aircraft field both the U.S. Navy and Air Force have a number of new, or relatively new, types on display which have not been previously seen in Europe. All supersonic aircraft, they give the American exhibits a "record breaking" theme.

Newest of the U.S. Navy types are the North American A3J Vigilante and the McDonnell F4H-1 Phantom 2, both from the Naval Air Test Center at Patuxent River. The Phantom 2 has been in service with the U.S. Fleet for a matter of months and the Vigilante is expected to be equipped to operational squadrons later this year.

The Vigilante on show is the actual aircraft which set up the World altitude record of 91,450.8 ft. on Dec. 13, 1960, for land-based jet aircraft; it carried a payload of 2,204 lb. Produced by North American Aviation's Columbus Division, it is in the Mach 2 speed class and can carry a wide variety of armament, including nuclear weapons. It is powered by two General Electric J79 turbojets.

An unusual feature of the Vigilante is its "linear" bomb bay. This is a tunnel running lengthwise in the aft section of the fuselage through which the bombs are ejected rearward.

The aircraft is at present undergoing various evaluation and test programmes by N.A.T.C. pilots prior to joining the U.S. Fleet. It completed its first carrier suitability tests last summer aboard the U.S.S. "Saratoga," and since then it has operated from the carriers "Midway" and "Ranger." Its visit to the Paris Aero Show marks the Vigilante's first crossing of the Atlantic.

Second of the Test Center's aircraft on show, the Phantom 2, has established two speed records for closed circuits: 1,216.78 m.p.h. for the 500-km. triangular course and 1,390.21 m.p.h. for the 100-km. circular closed course. It has also attained an altitude of 98,557 ft.

Aerodynamic features of the Phantom include full-span leading-edge flaps; boundary layer control on both wing leading- and trailing-edges; and variable geometry intakes.

SWEDISH VISITOR.—The attractive Malmö Junior shoulder-wing two-seater.

In addition to these two types, the U.S. Sixth Fleet in the Mediterranean has sent to the Show a Chance Vought F8U-2N Crusader, a Douglas A4D-2N Skyhawk, a Douglas F4D-1 Skyray, a Grumman S2F Tracker, and a Grumman W2F Tracer from the U.S.S. "Forrestal."

Although none of these types are new to this side of the Atlantic, they do represent U.S.N. aircraft currently in service. The Skyhawk is the smallest and lightest U.S. jet bomber and the Crusader was the first aircraft to establish a U.S. national speed record of over 1,000 m.p.h. Powered by a J57-P-4A turbojet, its outstanding features are a two position variable-incidence wing and a retractable flight refuelling probe.

Outstanding of the U.S.A.F. aircraft to be seen for the first time at Paris are the Convair B-58A Hustler and the Republic F-105D Thunderchief. The Hustler flew in last Friday after a non-stop flight from Carswell A.F.B., Fort Worth, Texas, via New York at an average speed of 1,105 m.p.h. It covered the 3,650 miles from New York in 3 hr. 19 min. 41 sec.

The Thunderchief on show is from the 36th Tactical Fighter Wing at Bitburg A.F.B., Germany. The first 12 of these fighter-bombers arrived in Europe last month and it is planned that the 49th Tactical Fighter Wing at Spangdahlem A.F.B., will also receive Thunderchiefs at a later date. They are replacing F-100 Super Sabres.

A single-seat all-weather fighter bomber, the Thunderchief has one Pratt & Whitney J-75 P-19 25,000-lb. plus, turbojet and is capable of Mach 2 at altitude. Although no weapons are on display, the aircraft can carry both internal and external armaments. These include thermonuclear and conventional bombs, clusters of rockets and guided and unguided missiles. It also has one Vulcan automatic 20-mm. cannon capable of firing 6,000 rounds per minute.

Republic are developing for the Thunderchief a reconnaissance pack which fits into its bomb bay. Employing cameras, infra-red and side-looking radar sensors which are coupled to the aircraft's navigation system, this pack also has a forward-looking radar to acquire target prediction information in conjunction with the forward oblique camera.

Another "first time in Europe" is the Kaman H-34B Huskie helicopter. A turbine-powered version of the earlier piston-engined H-34A, the H-34B is employed by the U.S.A.F. for crash-rescue and similar operations. Under existing contracts, Kaman will deliver a total of 116 of these helicopters to the Service and is developing the HU2K for the U.S. Navy.

Like its predecessors, the HOK, HUK and H-34A helicopters, the H-34B has two main intermeshing rotors and no tail rotor. It has a servo-flap system using small flaps on the rotor blades to control the pitch of the blades. Power is provided by a Lycoming T-53 turbine.

French exhibits include a mock-up of the Sud-Aviation S.A. 3210 Super Frelon helicopter. Developed from the three-engined Frelon which made its first public appearance at the 1959 Salon, the Super Frelon is powered by three Turboméca Turmo 3 turbines and can carry up to 26 people.

Featured as a troop transport, the Super Frelon can also be employed for heavy-load lifting and anti-submarine work. It has amphibious characteristics similar to those of the Sikorsky S.61; its maximum gross weight is 25,350 lb., and its normal operating weight 24,250 lb. At this latter weight the Super Frelon has a cruising speed of 119 knots and a maximum speed of 135 knots. Hovering out of ground effect is expected to be possible up to 9,200 ft.

Although expected, the Dassault Mirage IV-01 bomber prototype did not arrive in time for the official opening of the Show, the Mirage IIIC, however, was on display from the start. Powered by an Atar 9 with variable afterburner, the Mirage IVC is shown with a variety of external loads, including drop tanks, rocket and cannon packs, H.E. and napalm bombs.

An interesting Lockheed exhibit is the C-130 BLC boundary-layer control Hercules which is making its first public

(*Continued on page 624*)

Above and right, the MacDonnell F4H Phantom II, now in service with the U.S. Navy, has been up to 98,557 ft. Powered by two J79 turbines it has Mach 2 capability.

Left, the four-seat all-metal Cherokee has replaced the Piper Tri-pacer in production and marks the change in company policy to low-wing layout.

Paris Show Report . . .

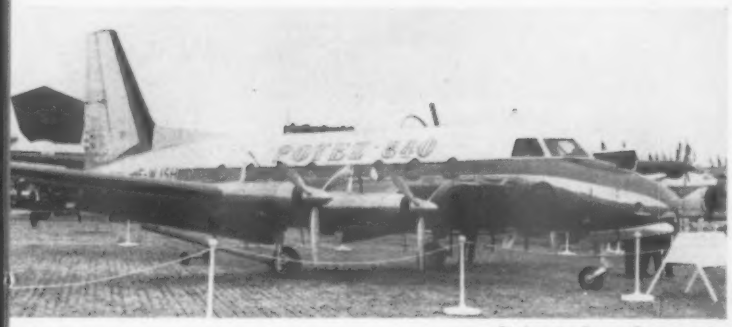
VARIETY ON SHO

Record-breaking supersonic bombe
wings, executive aircraft and small
U.K. and, of co

Above, not scheduled to appear at Paris and very much unsung of recent months, the Russian Tu-114 arrived on the first Friday in very poor weather. It was first seen there two years ago.

Above, the Mach 2 Thunderchief with an R.A.F. Britannia behind. The Thunderchief, 12 of which have been in Europe since last month, are replacing the F-100 Super Sabres of the U.S.A.F.E.

Right, with the aid of air-refuelling the Convair B-58A Hustler flew from Fort Worth, Texas, to Paris. The time from New York was 3 hr. 20 min.



Left, a specifically new transport in the show on the opening day, the Potez 840 made its initial flight only a few weeks earlier. With four Astazou turboprops it carries 16/24 passengers.

Right, the Super Broussard, built by Max Holste, made its first appearance with twin Bastan turboprops. It has been sold in Australia and New Zealand.

Below, shown in U.S.A.F. colours, the twin-jet Sabreliner is also being canvassed as suitable for the executive market, cruising at 500 m.p.h. and carrying six passengers.

W AT LE BOURGET

s, military and civil transports, rotary single-engined craft from the U.S., the rse, from France.

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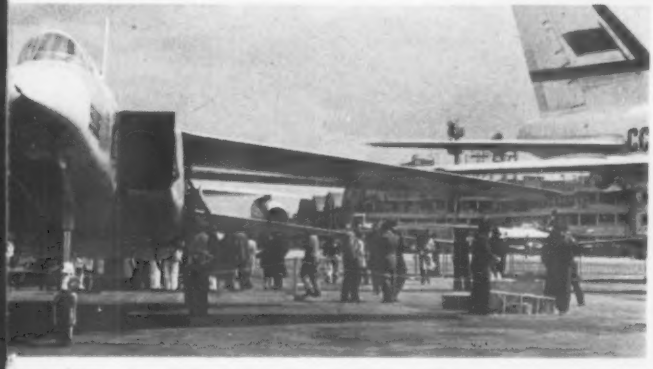


Right, employed by the U.S.A.F., the Kaman H-34B Huskie made its first appearance in Europe. It is powered with a single Lycoming T-53 of 720 e.s.h.p.

Left and below, the Mach 2 Vigilante, built by North American, is about to join the U.S. Fleet. This machine broke a record by carrying a 1-ton payload to 91,450 ft.

MODEL PROJECTS.—Left to right, top: Super Caravelle, Spirale III, Piaggio-Douglas 808, and SIPA Presence; bottom: Westland-Bristol 194, the Saab 105, and Bertin VTOL.

(Continued from page 621)

appearance in Europe. Demonstrated at the British Aircraft Corporation's airfield at Wisley last week, it is going on to Bonn and Rome after the show.

In this prototype version high velocity air for the boundary-layer control system is provided by two pylon-mounted low-compression engines outside the outboard powerplants. But in a proposed Rolls-Royce-engined version of the C-130 BLC, Tynes will supply power for both the propellers and the compressors which provide the boundary-layer control air.

Also on display for the first time is the Northrop T-38 Talon basic jet trainer which is now in service with the U.S.A.F. Air Training Command at Randolph A.F.B., Texas. More than 210 of these supersonic trainers are on order for U.S.A.F., and will replace both the T-33 and the F-100F in the Command's advanced training syllabus.—P.R.R.

MODELS AND PROJECTS

Among the projects and future types displayed in the main exhibition hall at Paris are two groups of special interest: the light jet executive transports and the light turboprop transports for the French Air Ministry competition. Taking the second of these groups first, Dassault sprang a complete surprise by exhibiting their Spirale III project, entered jointly with Sud in the design competition. This design is based on the Spirale 01 prototype built some years ago for ground-attack duties, particularly in French Africa; the wing and tail unit have been scaled up in the ratio of 1.3 : 1, and a completely new freight-carrying fuselage has been designed. The wing is high-mounted on a rear-ramp-loading fuselage.

In a rather smaller category, the Hurel Dubois HD130 features the classic Hurel high aspect ratio wing and has a swing tail for ease of loading. The cabin can accommodate a medium-sized car, up to 15 passengers or 3,750 lb. of freight. Powered by two 530-b.h.p. Astazou turboprops, this aircraft has a gross weight of 12,600 lb. and cruises at 220 m.p.h.

An alternative project by the same company, the HD 109A, has the same fuselage, but a conventional low wing.

The HD 109A bears a remarkable resemblance to the SIPA S.272 Présence, a model of which is shown in addition to the partial fuselage mock-up in the outdoor park. With two Astazou IIs, the Présence weighs 10,736 lb. and can carry a useful load of 4,122 lb. Loading is through a swing nose.

Other projects, rather better known, in the same general category, include the Max Holste M.H.261, the military version of the Super Broussard, and the Breguet Br.945, a small edition of the 941 Integral.

In the light jet aircraft category, there are models and brochures for four aircraft, all of which are being built at the present time—the de Havilland D.H.125 Jet Dragon (described in our previous issue); the Piaggio-Douglas PD-808; the Saab 105; and the Aero-Jet Commander 1121.

The PD-808 is a Douglas design, two prototypes of which are being built by Piaggio in Italy with financial support from the Italian Government. Flight trials will begin in 1962, and Piaggio state that one of the prototypes will be powered by Piaggio-built Bristol Siddeley Viper Mk. 22 turbojets.

The Jet Commander 1121 has two 2,850-lb.st. General Electric CJ610 turbojets. Also rear-engined, the Jet Commander has a high wing, with a span of 43 ft. 4 in. Gross weight is 14,000 lb., and the design cruising speed at 20,000 ft. is Mach 0.8. The range is 1,500 naut. miles.

Saab expect to fly a prototype of the Model 105 in 1963 and could begin deliveries in 1964, although the programme at present does not go beyond a single aircraft. This high-wing aeroplane has its two turbojets in nacelles under the wing-fuselage junction and is aimed initially at the military market.

Another project of specifically military interest is the Morane Saulnier 1510 Epervier II, developed from the Epervier I prototype which has been flying for some time. The Epervier II, with a Bastan IV and a retractable undercarriage, is described as a STOL aircraft for Army co-operation and ground-attack.

In a class all on its own is the highly interesting DFS 582 high-altitude powered glider for meteorological research. Designed at the Munich Aeronautical Research Institute, the DFS 582, of which two examples are being built by Weser at Bremen, makes extensive use of metal honeycomb structures.

With an NACA 643-618 aerofoil, the wing has an aspect ratio of 20 : 1 and a span of 98 ft. Operations will normally be flown at a speed of Mach 0.3/0.4 at altitudes of up to 60,000 ft. For take-off, climb and landing, the DFS 582 has a Pratt & Whitney JT12 turbojet of 3,000 lb. thrust in the rear fuselage. The cabin is pressurized for a maximum cabin altitude of 24,600 ft. Gross weight is 9,300 lb. The first DFS 582 is expected to fly about this time next year.

On the British Aircraft Corporation stand additional information is given about the BAC One-Eleven and the Super VC10. As we indicated when first describing the One-Eleven short haul jet in our issue for May 11 considerable "stretch" is already being worked into the design for the B.U.A. requirement to fly between London and Malta non-stop. Payload-range curves for the aircraft exhibited at Paris show a range of 700 st. miles with 14,000 lb. payload for the standard version.

Details of the Super VC10, which, as announced last week, now accounts for 30 of B.O.A.C.'s total order for 45 of the VC10 family, show that it is 13 ft. 8 in. longer than the "standard" aircraft, seating 163 instead of 135 in the B.O.A.C. layout. Maximum high-density accommodations are 150 and 180 respectively. Using an identical wing and tail unit, the VC10 and Super VC10 will be powered, respectively, by 21,000-lb. Conway RCo.42-1 and 22,500-lb.st. RCo.42-3 engines.

One looked in vain at Paris for indication of aircraft in the same category as the BAC One-Eleven. As we said a week or two ago, prospective competitive threats came from Sud with the Spey-engined Caravelle Junior and from Fokker. It now seems probable, however, that the Caravelle Junior will be dropped in favour of the supersonic Super Caravelle, of which there is a majestic model at Paris.

The Fokker project, understood to be based on two Bristol Siddeley BS 75s and identified as the F.28, is rather smaller than the One-Eleven and would compete more directly, in size and time-scale, with the BAC 107. It is described by Fokker as no more than a current design study at the present time.

Armstrong Whitworth announced at this Show that work is to begin on the Argosy Series 200, for deliveries in 1963. They will differ from the 10 Series 100s sold to Riddle and B.E.A. in having a fail-safe box-spar wing, saving about 1,000 lb. in structure weight, and a number of other new design features "to meet the requirements of several potential customers." The Series 200 will be powered by Dart RDa.7s.—F.G.S.

FULL-SCALE MOCK-UPS.—The S.A. 3210 Super Frelon (left) and the Broussard Major.

Paris Show Report . . . .

Around the Powerplant Stands

ENGINES once again dominate the display in the main exhibition hall at Paris, although on this occasion rather fewer than usual are being exhibited for the first time. It is good to see that the impressive displays by ROLLS-ROYCE, BRISTOL SIDDELEY, and—as part of the Hawker Siddeley Group stand—BLACKBURN ENGINES and THE DE HAVILLAND ENGINE CO., match those from the United States. These British aero-engine exhibits were, of course, described in our previous issue and the following notes will be confined to the American and other powerplants on show.

Most interesting of the SNECMA exhibits was a display panel announcing the TF106—a French development of the Pratt & Whitney JTF10 turbofan. Few details are available but a diagram shows that afterburning is to be used in both the main and the fan effluxes; maximum thrust is quoted as 9,000 kg. (20,000 lb.). Turbofans with afterburners are among the engine types currently of interest for supersonic transports.

Another example of SNECMA-Pratt & Whitney collaboration, apart from the JT4A turbojet on the French stand, is the demonstration of the SNECMA thrust reverser applied to the JT8D-1 turbofan—the engine for the projected Caravelle X. This reverser, comprising eyelids in the jet stream and cascade outlets round the rear of the nacelle fairing, is designed to be used in the air for approach control. By applying partial reverse thrust, it is possible to obtain very steep angles of descent and to maintain control in the glide path; full reverse is applied at touch-down.

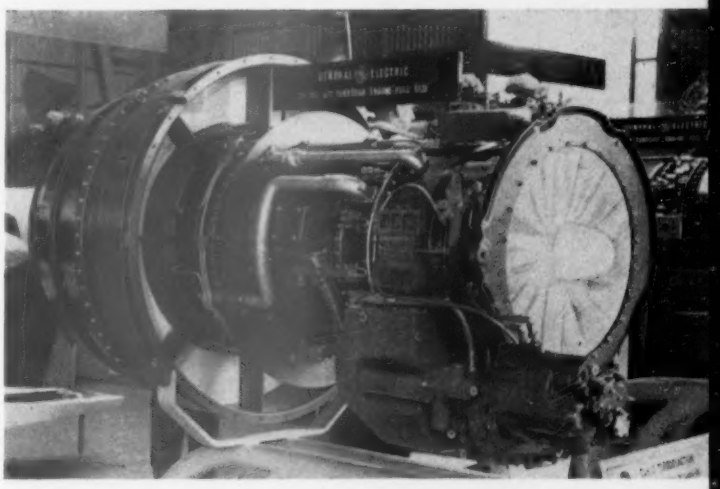
Also shown by SNECMA were an Atar 8, which powers the Etendard, and the Atar 9, which in different versions powers the Mirage IIIC and IIIE, and the Mirage IV.

TURBOMECA—after SNECMA the best-known name in French aero-engines—display their full range of small turbojets and turboprops, including the interesting Turmo IIID-2 with its propeller and auxiliary drives for the Breguet 941 Integral. This same engine, without the auxiliaries, is specified for the Dassault Spirale III, one of the completely new projects revealed at the Show. Also on show is the Astazou II turbo-prop, the newest version of which develops 600 h.p. and weighs 123 kg. (270 lb.).

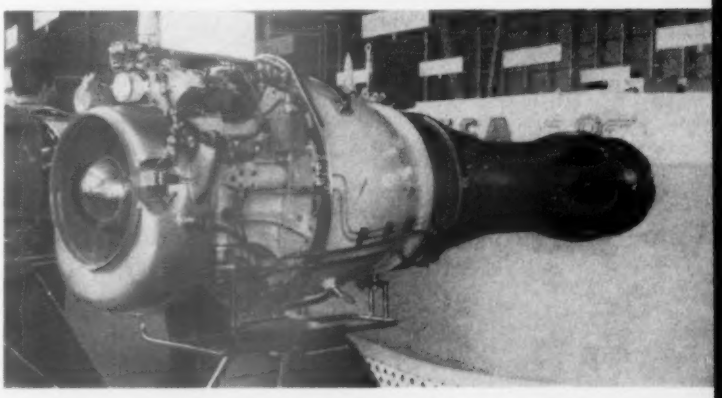
In conjunction with Bertin, Turboméca are displaying their Marboré fitted with a Bertin silencer of the so-called "pamplemousse" (grapefruit) type, which functions, like most of the Bertin designs, on the principle of adding cold air to the hot exhaust, and then splitting the efflux into a number of separate streams. Silencers of this type are now being test flown on the Marborés in a Fouga Magister.

SEPR has for long specialized in rocket engines, and now has in production the Model 844 rocket pack for the Mirage IIIC interceptors of l'Armée de l'Air. This is intended primarily as a power-booster on the climb and delivers 3,700 lb. thrust at 52,500 ft., at which altitude the specific fuel consumption is 9.5 lb./lb./sec. Fuel is nitric acid and TRO or TR4 kerosene.

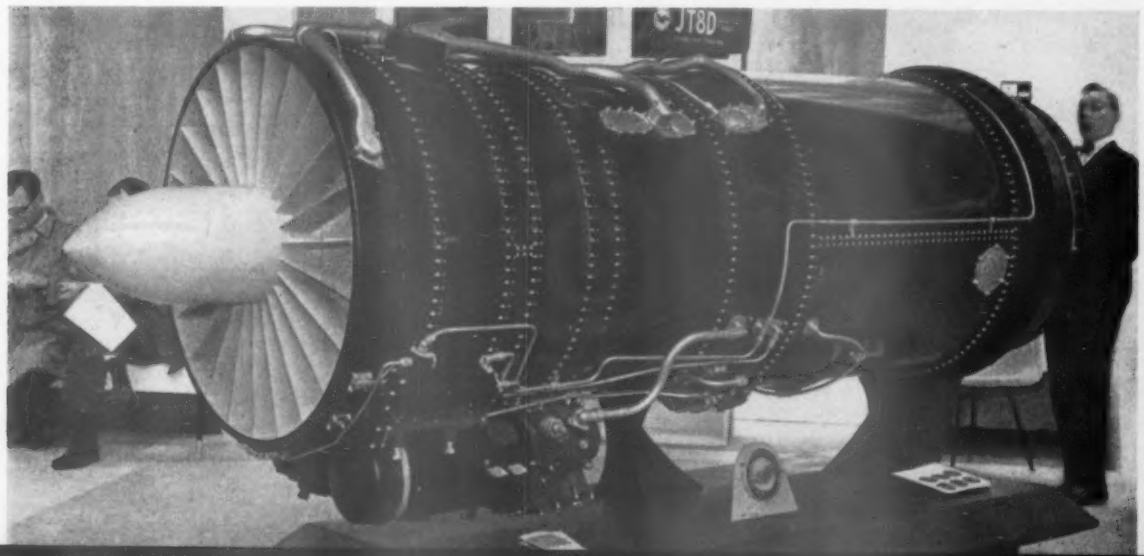
Looking towards the future, SEPR has a montage of possible

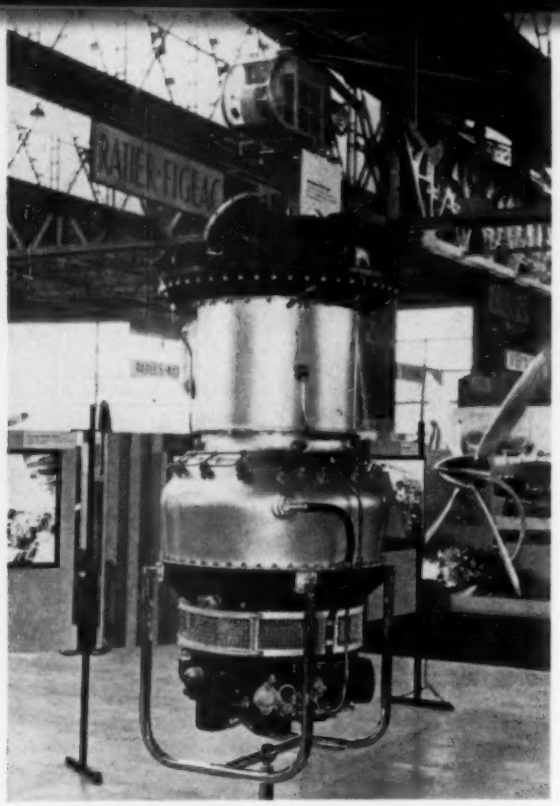


Above, among the range of small engines on the General Electric stand is this CF700 turbofan powerplant developed from the 2,500-lb.st. J85.

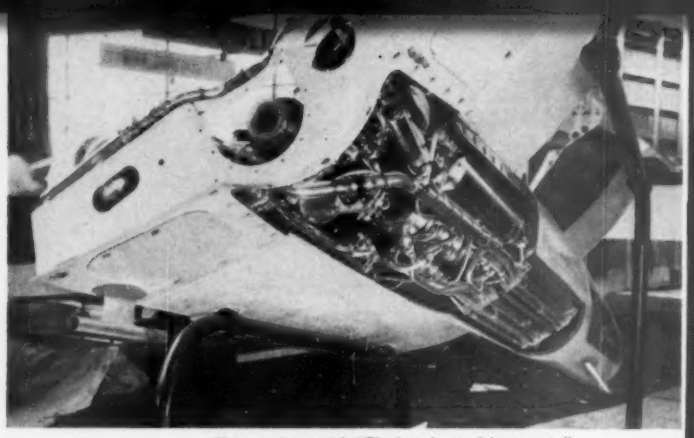


Above the Turboméca Marboré equipped with a Bertin "grapefruit" silencer. Below, the Pratt & Whitney JT8D-1—a 14,000-lb.st. turbofan for the Boeing 727 and Caravelle X.





The Fiat 4700 helicopter powerplant is a free-turbine engine driving a compressor which supplies air to the "cold" tip-jet drive of the Fiat 7002 helicopter.



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This SEPR rocket pack is for the Mirage III in which it is used as a climb booster.

Paris Show Report . . . .

powerplants for missiles and space vehicles. The spectrum was broadly indicated as follows:—

Chemical reaction—specific impulse, 400 sec.; thrust, several hundreds of tons; duration, 15 minutes.

Nuclear propulsion—specific impulse, 1,000 sec.; thrust, several hundreds of tons; duration, 10 minutes.

Plasma jet—specific impulse, 2,000 sec.; thrust, "some tens of grammes"; duration, three weeks.

Ion jet—specific impulse, 60,000 sec.; thrust, "some tens of grammes"; duration, three months.

SEPR also show a small demonstration model of a plasma jet, which takes its energy from the sun and ejects a plasma of helium.

GENERAL ELECTRIC show examples of almost all their current engines, ranging in size from a sectioned CJ805-23 turbofan and the "exploded" J79-11A (which is the basic powerplant for the European F-104G Starfighter programme) to the versatile little J85.

An example of the last-named engine—which has its most important application at the present time in the Northrop T-38 Talon, with afterburning—was shown as developed for vertical thrust applications.

This has been under development for only a year or so, but is successfully running on test stands. Stripped of all unnecessary weight, the VTOL J85 exhibited has a thrust-to-weight ratio of 10.3 : 1. Further developments along these lines might be to use a turbofan version of the same engine, which would have a similar thrust/weight ratio, but a better s.f.c.

Most of General Electric's studies on VTOL have been devoted to the lift fan propulsion system, and a small model is used to demonstrate the principle. The lift fan comprises three basic components: a turbojet engine, a diverter valve and a large-diameter lift fan. In the tests with this system to date, the 2,500 lb.st. J85 is being used, and produces a lift of 7,500 lb. through the fan for vertical flight.

The lift fans are mounted in the wings and covered by louvres or slats. For vertical operation, all the engine exhaust is diverted to the turbine disc at the outer edge of the fan; for transition to forward flight, the louvres under the fan are first set to develop a forward thrust component and then, when adequate forward speed has been obtained, the full engine thrust is diverted to conventional exhausts. The louvres above and below the fan are then closed to fair off the wing surfaces.

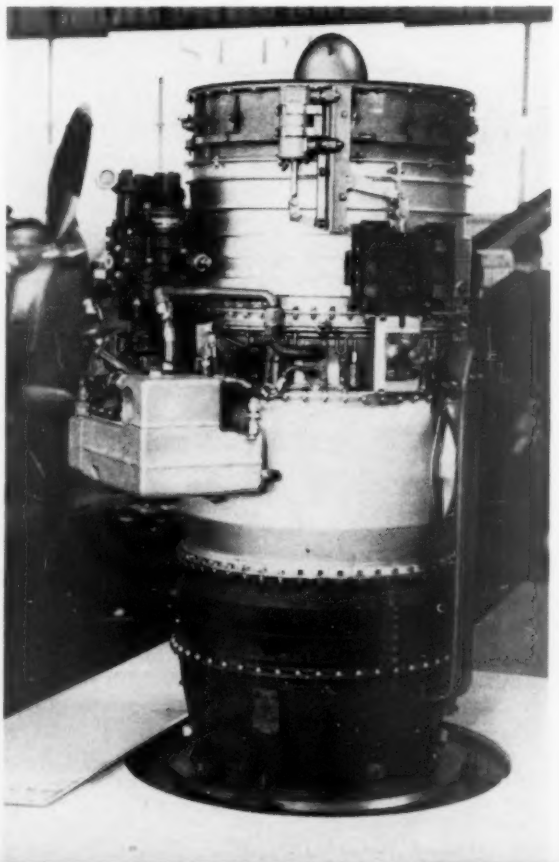
For control in vertical flight, an additional fan is located in the forward fuselage, and takes its power from the same source as the main fans. General Electric propose two engines, cross linked so that if one fails, power continues to be applied to both fans.

Preliminary trials with the system have been made at a special test facility at Evendale, where a single fan unit powered by a single J85 has completed some 40 hours of test running. The whole assembly, mounted in a mock-up of a VTOL airframe, has also been tested in the 40 ft. x 80 ft. NASA wind-tunnel at Moffett Field. A second lift fan assembly is now being constructed and it is planned to make test flights by 1963, probably using an existing airframe such as a North American T2J-1 Buckeye.

The range of General Electric small engines on show includes the T64 turboprop; the T58 turboshaft for helicopters; and for civil aircraft, the CJ610 variant of the J85, and its turbofan development, the CF700.

Of particular interest on the PRATT & WHITNEY stand is the J58—rated as the JT11 at 23,000 lb.st. This engine, which was originally being developed for possible use in the Mach 3 North American B-70 and F-108, has been tested and is still supported by military funds, although it has no immediate aircraft application. It is, Pratt & Whitney claim, a prospectively suitable engine for supersonic transports, and is sufficiently developed to justify further work being done.

In a particularly interesting brochure issued by Pratt & Whitney on the subject of Supersonic Transport Propulsion, the suggestion is made that for Mach 2, a turbofan engine with duct heating augmentation offers great promise. This is



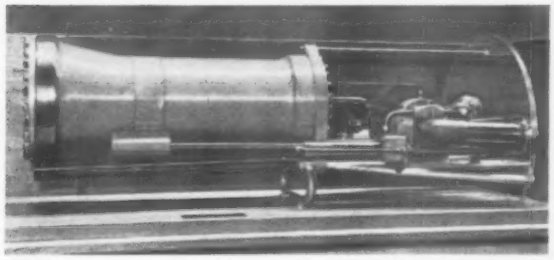
Right, the General Electric J85 adapted as a VTOL engine for vertical installation.

qualified by the statement that some penalty might have to be accepted in cruising economy in order to obtain better economy at off-design conditions, and also to obtain some improvement in noise characteristics and specific weight.

For Mach 3, this brochure shows, the company has concluded that a turbojet or turbofan with some form of augmentation and having a moderate design compression ratio (about 8 : 1 at sea level) seems most attractive. This ratio is equivalent to 3.9 : 1 operating pressure ratio at Mach 3. The turbo-ramjet (of the type represented by a display on the French Nord stand) might offer some advantages for Mach 3 and above, say Pratt & Whitney; but " to achieve . . . the reliability consistent with commercial operation would seem to involve extensive pioneering in several unexplored problem areas."

Exhibited for the first time, is the Pratt & Whitney JT8D-1 turbofan, which has been chosen to power the Boeing 727 and is specified for the Caravelle X project. It is rated at 14,000 lb.st., but few other details are given. This engine is derived from the J52, in production for U.S.N. and U.S.A.F. applications, and features the front fan arrangement.

This was first developed for the JT3D, the fan version of the military J57 and civil JT3C. Together with a sectioned example of the JT3D, Pratt & Whitney describe a whole family of variants of this engine, to cover a range of thrusts from 17,000 lb. to 24,000 lb. In the initial variants, the JT3D-2 and -4, the first two stages of the basic J57 compressor are replaced



This model of liquid-propellent rocket motor is on the Svenska Flygmotor stand.

by fan stages, and the third stage is omitted. The thrust rating is 17,000 lb.

The next stage, the JT3D-8A (21,000 lb.st.) and JT3D-8B (23,000 lb.st.) is obtained by replacing the third compressor stage. The JT3D-8A rating was demonstrated on the test bench in December, 1960. Finally, the JT3D-12 (22,000 lb.) and the JT3D-14 (24,000 lb.) have the third compressor stage replaced by a third fan stage, and a larger turbine. The t.s.f.c. of these models drops below 0.75 for a thrust of some 4,000 lb. cruising at Mach 0.8 at 35,000 ft.

Also exhibited for the first time are Pratt & Whitney's JFTD12 and the PT6A. The former is a turboshaft version of the JT12 turbojet, and is to fly before the end of the year in the prototype Sikorsky S-64 Skycrane. It is rated at 4,050 s.h.p. The 500 s.h.p. PT6, developed by Canadian Pratt & Whitney, is available as a turboprop or a turboshaft engine, and has recently begun its flight trials.

On the UNITED AIRCRAFT stand, are models of three solid fuel rockets developed by the United Technology Corporation. These are the S.3, a three-stage rocket 55 ft. long, with 200,000 lb. of fuel and a 730,000-lb. thrust for 60 seconds; the S.5, an 80-ft. long five-stage rocket with 330,000 lb. of fuel,

Canadian Pratt & Whitney's attractive little PT6 turboprop engine.

giving 1,250,000 lb. for 60 seconds, and the S.10, 130 ft long with 10 stages, containing 650,000 lb. of fuel and delivering 2,500,000 lb. for 60 seconds.

On the German industry stand, B.M.W. TRIEBWERKBAU GMBH show for the first time their diminutive B.M.W. 6012 turboprop. Developed from the Model 6002, this unit weighs only 100 lb. and has a quoted power of 88.8 h.p. It can be hand started by a cranking handle and is self-sustaining at 10,000 r.p.m.; idling speed is 20,000 r.p.m. and maximum operation is at 45,000 r.p.m. The B.M.W. 6012 is suitable for small aircraft and helicopter applications as well as the more obvious one of auxiliary power supply.

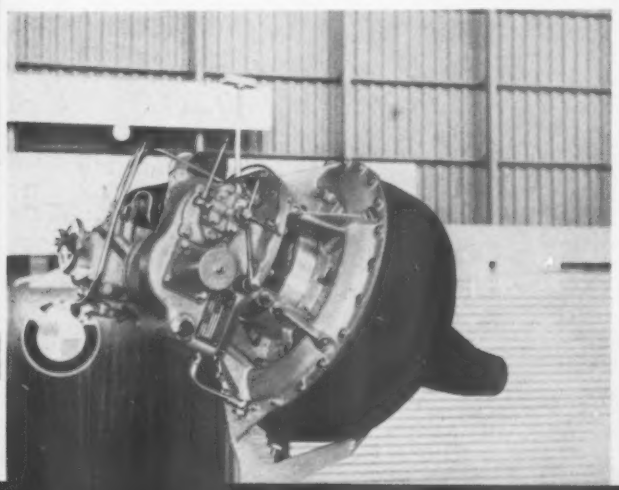
The B.M.W. 8026, also shown, is a small turbojet weighing 84 lb., and developing 110 lb.st. Its primary application is for powered sailplanes such as the Allgaier H 30 TS, which has been flying for some time. B.M.W. also exhibited a Lycoming GO-480-B1A6 piston engine, for which it holds the German production licence.

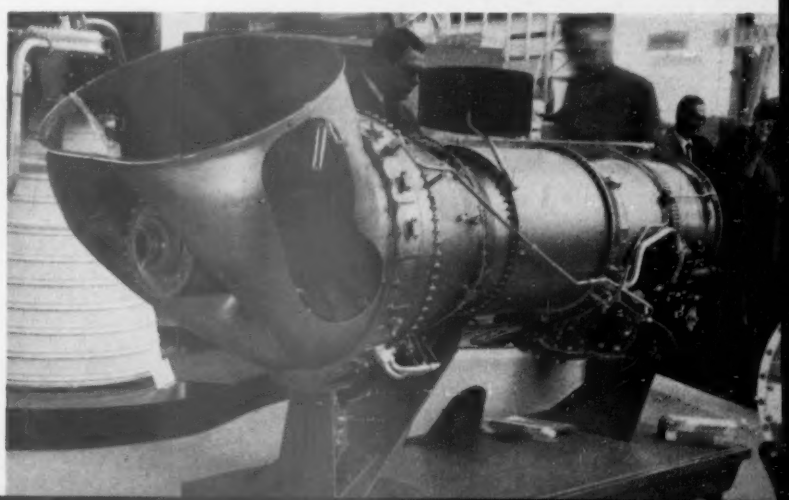
FOCKE WULF are demonstrating direct jet lift nacelles which could be added to military transport such as the Transall to obtain VTOL performance. Vertically inverted in pods with retractable fairings to cover the intakes and outlets during the cruise, the jet lift engines can be tilted to give a degree of forward thrust or retardation as well as vertical thrust.

Among the engines on the Italian stand was a Bristol Siddeley Viper ASV 11 Mk.22-1 manufactured under licence by PIAGGIO. This 2,500-lb.st. turbojet is an optional engine for the Piaggio-Douglas PD-808 light jet transport and will power the second of two prototypes now being built. It is in production in Italy for the Macchi MB.326 trainer. Piaggio, too, exhibited their licence-built Lycoming engine used in the Piaggio P.166.

FIAT exhibits included the Fiat 4700 engine for the Fiat 7002 helicopter. Other Italian engines on show were the AGUSTA MV.120-140, which powers that company's light helicopters, and the METEOR Alpha eight-cylinder radial which is used in the Meteor P.1 target drone.

Below left, the diminutive B.M.W.6012 turboshaft engine for aircraft and APU applications. Below, the 4,050 s.h.p. Pratt & Whitney JFTD12 free-turbine engine for helicopters.





Paris Show Report . . . .

Accent on Space

HAD the Mercury capsule—"Freedom 7," the very one which made the U.S. sub-orbital flight on May 5—been placed among the major exhibits it would undoubtedly have been true to describe it as the centre of interest at this year's Salon. The capsule is, in fact, somewhat hidden away in the separate U.S. space exhibition, where it was placed soon after its arrival late on May 25. Some of the earlier visitors may not even have known of its existence.

Nevertheless, the very fact of the appearance of this "veritable" space capsule is not only a feather in the cap of the U.S. authorities but is symbolic both of the trends of the era and of the importance attached by the U.S.A. to this, the biggest of international aviation exhibitions.

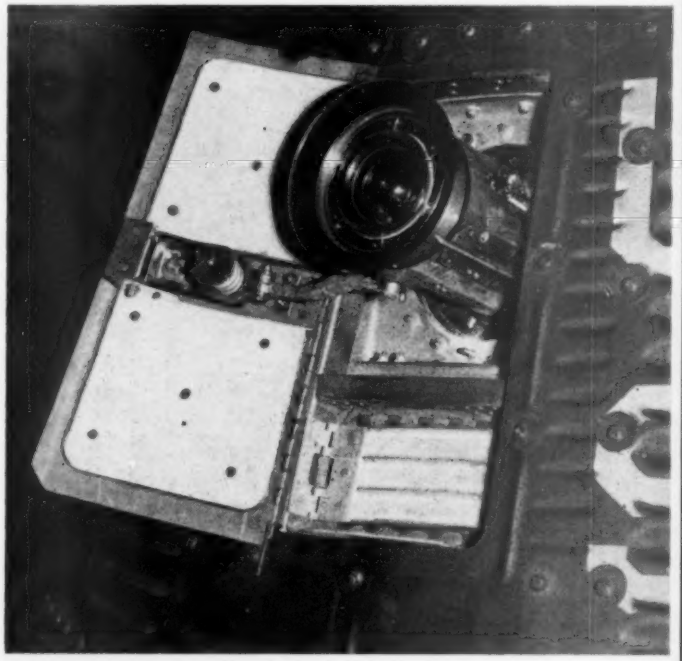
"Freedom 7" seemed to be complete in nearly every respect except for the re-entry heat shield and the hatch—which had been lost during recovery and has been replaced by a transparent cover which permits a fair view of the claustrophobic interior arrangements. A fully equipped dummy astronaut is installed and visitors are able to appreciate the complex rigours of the human environment. The periscope is shown in its extended position and the dummy, facing the instrument/control panel, holds the "abort" lever in its left hand and the manual orientation control in its right hand. The whole thing provides an impression of the realities which no amount of descriptive writing or illustration can possibly replace.

The U.S. space exhibition—in a "geodetic tent" beside the missile park—includes a wide series of individual demonstrations, though not all of these are likely to be understandable to the interested layman. The exhibits also include a series of ingenious demonstrations of the air traffic control development work being done by the Federal Aviation Agency. The principal space exhibits, apart from the capsule, include a mock-up of a representative boost-glide cockpit, various applications for the Discovery series of satellites and the "tented" open gondola of the balloon from which the 102,800-ft. parachute drop was made last August.

The Discovery exhibits included reference to "Snap 3." This is a miniaturized nuclear generator developed by Martin. The latest "Snap" (the word stands for "System of Nuclear Auxiliary Power") is designed to produce power for 140 days, and an example has been in operation for a year, though now, as expected, giving no more than a fraction of a watt. Polonium 210 is used and heat is converted directly into electrical energy by thermocouples; there are no moving parts.

Several stands in the main exhibition demonstrated the work done, or being done, by U.S. manufacturers in particular, towards spacecraft development. This work includes that on magneto-hydrodynamics (pinch plasma engines) by Republic; Discovery re-entry and recovery vehicles by General Electric; an orbital astronomical observatory by Grumman; a lightweight communication satellite (32 lb. in weight and only 29 in. in diameter) by Hughes; and the Apollo three-man spacecraft (to follow Mercury) for moon orbit by Martin. Work on the last has been concerned with the shielding from radiation (from the Van Allen belt and solar flares in particular); a computer has been used to evaluate radiation levels and it has been found that a spacecraft can be designed so that only "spot" shielding is necessary—thus promising an essential and considerable saving in vehicle weight.

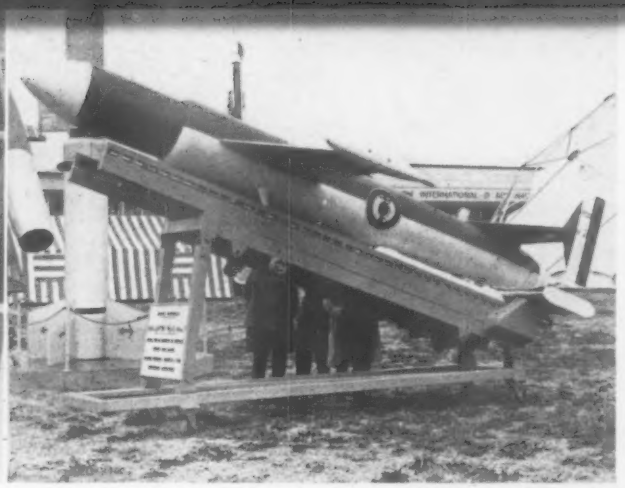
Overall, the visitors' impression will be one of the immense amount of co-operative work still to be done before manned vehicles can, even with reasonable safety, leave the relatively comfortable region of orbital operations.—H.A.T.



Above, the special periscope of the capsule shown in its extended position; this provides a "wide-angle" picture which is reproduced on a display on the instrument panel.

Left, inside the Mercury capsule "Freedom 7." The astronaut lies on his couch facing the instrument panel above him with the "abort" control in his left hand and the manual orientation control in his right hand. On the left is a mirror which provides an indirect view through the porthole.

Photographs copyright "The Aeroplane and Astronautics"



Extreme left, the new de Havilland Red Top air-to-air missile; left, the rocket boosted Latécoère ship-to-underwater Malafon Mk. 2. Below, the Matra 530 air-to-air missile; collaboration between Matra and de Havilland for development of a missile based on the 530 has been reported.

Photographs copyright "The Aeroplane and Astronautics"

Missiles Displayed

MISSILES, which formed so prominent a *motif* two years ago are noticeable by their absence rather than presence this year, mostly because of the specific exclusion of an official U.S. missile exhibit on political grounds. Both Britain and France display their current range of tactical guided weapons, including the newly revealed de Havilland Red Top. Originally developed as the Firestreak 4, this is understood to be the missile mentioned in the Air Estimates earlier this year.

Clearly a relative of the Firestreak from external comparison of the two examples on the Hawker Siddeley stand, the Red Top shares with it an infra-red homing system, but has been designed to undertake a different mission profile, and, as one would expect, has generally improved performance. The wing shape has been "optimized" and the tail unit is also of different shape.

Other British missile exhibits, including the new English Electric Blue Water, were reviewed in our previous issue.

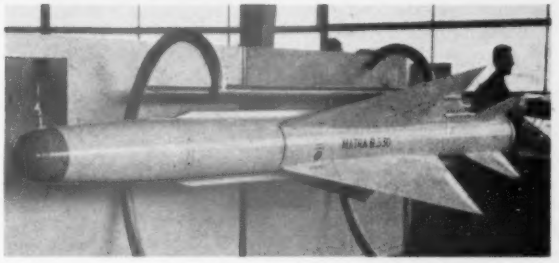
Among the French missile manufacturers, Nord occupies a prominent position, having built a total of 60,000 guided weapons by Jan. 1 this year, and made deliveries of these to 12 different countries.

The SS11 and SS12 are both basically anti-tank weapons but the similar air-launched AS11 is suitable for use from helicopters and light aircraft, and is in use on the MD311, Fouga Magister, Corsair, and Alouette II and III. The AS12 variant is used on the French Navy's Alizes.

The Nord AS30 is the newest of the weapons displayed. Weighing 1,150 lb., it is being developed to carry a nuclear warhead and is expected to become a standard air-to-ground missile in due course, on the Mirage III and Etendard IV. The AS20 is in use on the Mirage III, Etendard IV, Vautour and Fiat G.91.

Matra, another prominent name in French air armament, displays a wide range of its packs and pods for spin-stabilized rockets, including the Type 35 pod containing 35 x 2-inch rockets and suitable for the Hunter and Lightning. This pod, say Matra, has been developed in collaboration with the R.A.E. and may be produced in Britain by Thomas French and Sons, Ltd. The two Matra missiles displayed are the R.511, now in service on the Vautour all-weather fighters and the Naval Aquilons, and the new R.530.

The R.530 is an air-to-air missile destined for the Mirage IIIs of l'Armée de l'Air. It has cruciform delta-shaped wings and a cruciform tail. Propulsion is by means of a two-stage solid rocket, and both infra-red and radar homing variants are available. The R.530, scheduled to be in full scale production by 1963, is suitable for operation at altitudes from 0 to 30,000 m., weighs 195 kg. and is 3.38 m. long. Test firings have been made from a Canberra.



The Latécoère company, once famous for its aircraft, has concentrated since the War on other activities, including guided missiles, and has successfully developed the Malafon ship-to-underwater missile. Two examples are in the outside missile park—with noticeable differences. The Malafon Mk.2 exhibited by the French Navy is the present production standard; with a rocket boosted take-off, the 2,865 lb. Malafon is teleguided and flies at 431 knots.

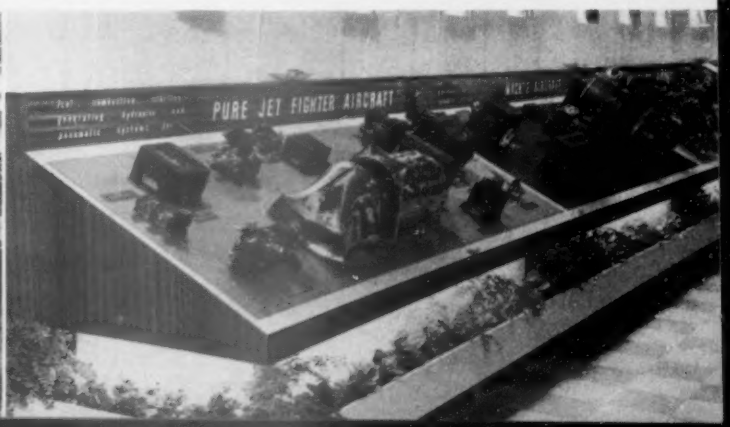
Although no U.S. missiles figure in the outside park, quite a lot are to be seen, full size or as models, inside. These include a range of models of the Martin missiles including Pershing and the variants of Bullpups. There are now three basic Bullpup versions, including the U.S. Navy type, the U.S.A.F.'s GAM-83, and the very much smaller T-GAM-83, a training missile which is compatible with the aircraft systems for the full size weapon.

Hughes exhibit their HM55 missile, a version of the GAR-11 now in service with the U.S.A.F. The HM55 is being offered to NATO nations for use on the European-built F-104Gs. It is designed to have an H.E. warhead (non-nuclear), for launch from Mach 2 aircraft and with optional infra-red guidance or semi-active radar homing.—F.G.S.

HAWKER SIDDELEY RESIGNATION.—As we go to press it is learnt that Mr. J. A. R. Kay, sales director of Hawker Siddeley Aviation, Ltd., will be resigning from the Hawker Siddeley organization as from June 30.

Mr. Kay was educated at Cheltenham College and served his apprenticeship with Sir W. G. Armstrong Whitworth, Ltd., and A. V. Roe and Co., Ltd., where he later held various appointments. He returned to A. V. Roe as general superintendent in 1941 after being managing director of Northern Aircraft and Engineering Products, Ltd., and director of Cornercroft, Ltd. He became director and general manager of A. V. Roe, Ltd., in 1950.

Prominent among the stands of the major British equipment manufacturers are those of the Plessey company (left) and Lucas-Rotax (right) both of whom had comprehensive and "stylish" displays.



Paris Show Report . . . .

Airborne and Ground Electronics

AN outstanding feature of the indoor exhibition at Le Bourget is the very large variety of electrical and electronic equipment on display. Covering a truly international field, this particular contribution to the Show includes both ground and airborne navigational aids, flight instrumentation, military fire-control systems and air traffic control aids.

Doppler navigators can be found on a number of stands and it is interesting to see how this navaid has developed over the past few years. Canadian Marconi are showing the antenna array from their latest design—the CMA-650-series for lighter aircraft such as military fighters, helicopters and civil executive types. This equipment, the complete prototype of which will be at Farnborough in September, has been initially developed for anti-submarine helicopters.

The actual antenna on display is mounted in a stabilized frame which can be tilted up to 70° in roll, ±15° in pitch and rotated through a drift angle of 40° before the equipment unlocks. The total weight of a typical fighter installation, including two "black boxes," antenna and indicators, is estimated to be less than 35 lb.

Laboratory for Electronics, Inc. (LFE), are exhibiting their APN-131 Doppler which is installed in the U.S.A.F.'s F-105 Thunderchiefs and is expected to be ordered for the U.S. Navy's F4D Skyrays.

The F-105 installation has a number of interesting features. These include autopilot operation, the automatic correction of any accumulative position error in the Doppler presentation by the aircraft's navigational radar, and a memory command switch for limited "silent" operation over enemy territory.

The automatic flight control system for the Draken is featured by SAAB. Known as the FH5, it is a three-axis system using information obtained from an air data computer and a stabilized platform. It provides aircraft attitude stabilization and stability augmentation around all the three axes. The stability system can also be used separately during manual flight.

Additional features that can be added to the basic FH5 system include attitude hold, Mach hold and "control stick steering."

To prevent any dangerous flight condition from occurring during automatic flight, manual override is incorporated in the normal way, together with two automatic acceleration devices. One of these disconnects the autopilot if a preset level of acceleration is exceeded, and the other distinguishes between wind gusts and equipment malfunctioning.

Other autopilots featured include the Sperry SP.40 designed for the medium jet market, and the S.F.I.M. Type 100 for the Sud Aviation Super Frelon helicopter. A later development of the Sperry SP.40 is the SP.50 autopilot for the Boeing 727. This latter equipment is to a special Boeing specification and incorporates hydraulic actuators in place of the electronic units in the SP.40. The S.F.I.M. Type 100 is derived from a Sperry system and includes such features as automatic hover control.

Sperry are also exhibiting for the first time their twin-gyro reference platform with its cover off, together with the associated electronic computer. Employing Rotorace bearings this platform provides attitude and directional reference information of inertial navigation quality for strike and reconnaissance type aircraft, without the need for liquid-supported gyros.

The Eclipse-Pioneer Division of Bendix have an integrated flight instrument display panel fitted with vertical strip indicators as installed in the F-105 Thunderchief and F-106 Delta Dart, and a 2-in. attitude indicator for the Canadian CF-104 Starfighters. A three-axis attitude indicator; a two-gyro three-axis stable platform; a self-contained latitude and longitude computer for the A4D Skyray; and an APN-141 radar altimeter are also featured. The APN-141 has an altitude range of 0 to 5,000 ft. and a stated accuracy of better than ±5 ft.; it is now the standard unit for the U.S. Navy and Air Force.

Ground-operated equipment in the exhibition includes an LFE AN/TPN-12 ground control approach system. Now standard for U.S.A.F. tactical GCA, it is also in service with the Royal Swedish Air Force which is having a total of 20 installations. The AN/TPN-12 operates as a conventional search radar in the scanning mode, detecting aircraft within a 40-mile range and displaying range and azimuth information in a single PPI presentation.

In the precision mode, the indicator display provides aircraft elevation angle with range, and azimuth information with range in the normal way up to a maximum of 20 miles.

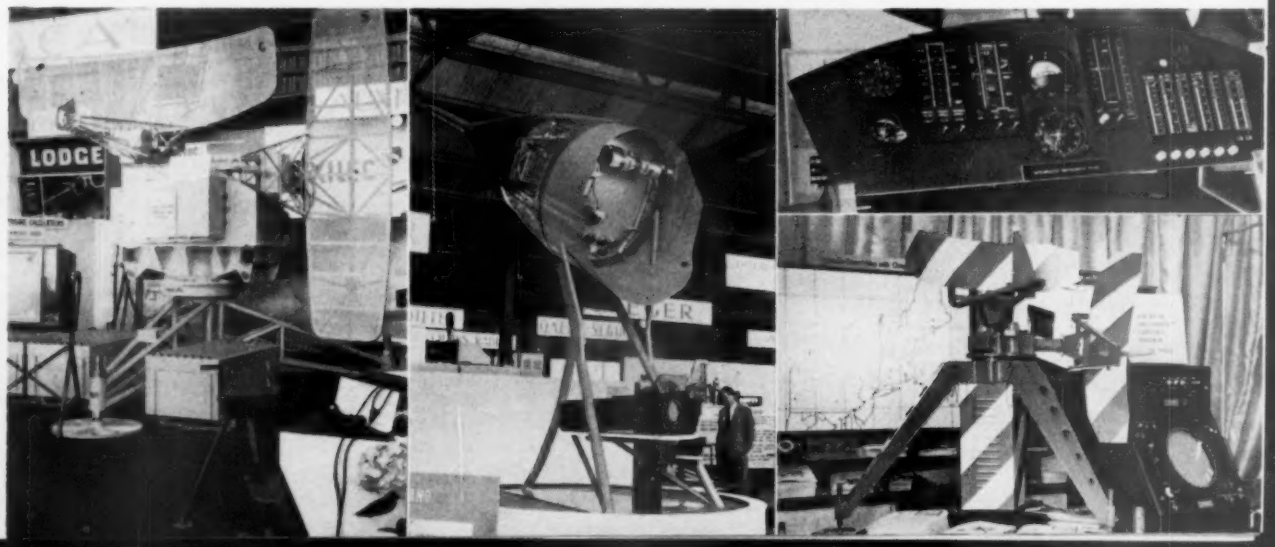
The Cyrano fire control radar system for the Mirage IIIC is exhibited by Compagnie Générale de Telegraphie Sans Fil (CSF). Consisting of a radar nose unit, including an analogue computer, pilot's search radar scope and attack sight, plus control boxes, the installation provides ground mapping as well as air-to-air interception facilities. Another version of the same equipment is designed to provide air-to-ground attack information for strike aircraft.

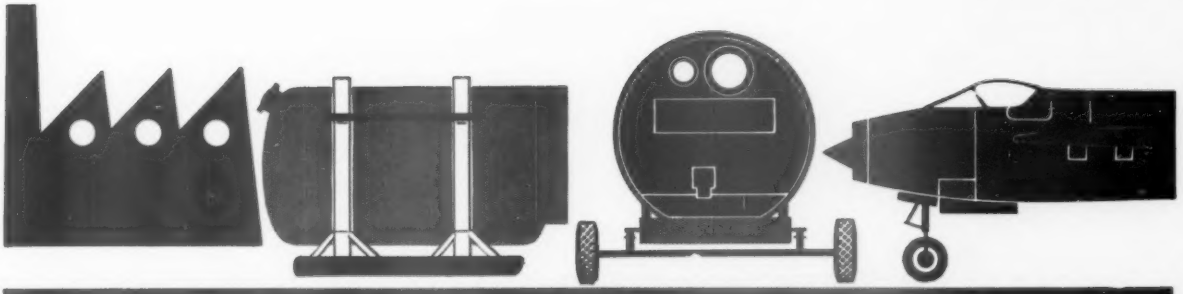
Other electronic equipment for the Mirage IIIC on display includes the S.F.I.M. heading reference unit. Providing both vertical and directional references with the aid of two gyros, this unit feeds the required information to the company's Type 40 artificial horizon, which is free to rotate through 360° on any of its three axes.

Aircraft instruments on the General Electric stand cover a wide-range mass flowmeter capable of measuring fuel flow between 20,000 and 125,000 lb./hr. with an accuracy of better than 1%; and a master flight reference system for providing direction and altitude information, together with integrated outputs for autopilot, Doppler, bombing and navigation computers, and dead-reckoning navaid equipment.

Hughes Aircraft are featuring a number of missile and aircraft control systems and components, including TARAN (tactical attack radar and navigator) systems for fighter-bombers such as the F-105 Thunderchief. The three basic capabilities of TARAN are automatic navigation to a target, in which the aircraft position is displayed to the pilot by a symbol on a moving map presentation; the picking out of ground-attack targets by means of a new high resolution radar, and search and track functions for the launching of either radar or infra-red guided air-to-air missiles.—P.R.R.

Below left, the aerials for the B.T.H. air transportable GCA equipment for the French Air Force. Centre, the Cyrano fire-control system for the Mirage III. Below, upper right, an integrated instrument display panel by Bendix-Eclipse. Below, lower, a quarter-scale scanner and a control console for the LFE portable tactical GCA system.





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Bonding and Sandwich Construction

By E. J. Catchpole,* M.S. in A.E., B.Sc.(Eng.), A.F.R.Ae.S.

IN 18 years of use since its introduction in the de Havilland Hornet in 1943, bonding has proved its advantages over other methods of joining for both primary and secondary structures. In that time the requirements for structures in terms of loading and environment have changed considerably, and other new methods of fabrication have appeared. But both metal-to-metal bonding and its newer partner, honeycomb sandwich construction, show signs of much more extensive use in the immediate future, both in the U.K. and abroad.

Metal-to-Metal Bonding

REASONS FOR USE.—Metal-to-metal bonding was originally adopted because of the increased structural efficiency resulting from continuous attachment of, for example, stringers to skins as compared with riveting or spot welding, subsidiary advantages being the smooth exterior finish and the simplification of sealing of pressurized cabins and integral fuel tanks. These advantages

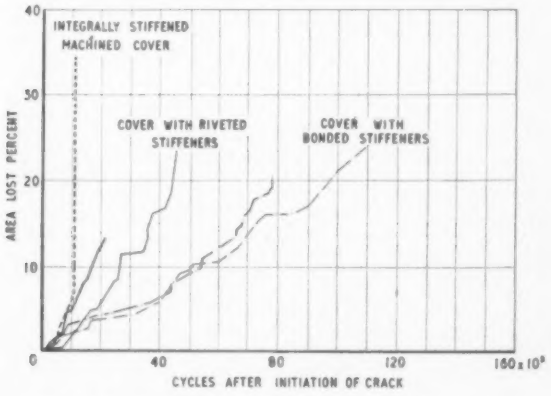


Fig. 1.—Crack propagation in aluminium-alloy box beams.

remain important, but increased interest in recent years has been particularly sparked off by the work done in the field of crack propagation.

It has long been known that fatigue life could be increased by eliminating the stress concentrations caused by rivets and spot welds. It was, perhaps, slightly surprising to find that bonding has a very large advantage over other forms of construction in that cracks, once started, propagate much less rapidly in the bonded structure.

Fig. 1 shows data taken from NACA Technical Note No. 3856 and this very clearly illustrates the advantage of bonding in this respect. Similar work on the crack-stopping properties of bonded stiffeners was carried out by the Bristol Aeroplane Company in this country (see the journal of the Royal Aeronautical Society, May, 1958, p. 369) and this confirms the NACA findings.

The most recent competitors of bonding for the manufacture of primary aircraft structures have been integral machining and chemical milling. Both of these solve the stress concentration problem and have undoubted attractions in that as in bonded structures the thickness and location of material can be varied easily to suit the load. On the other hand, they do not seem in principle to be right because they are wasteful of material, i.e. large quantities of alloy must be removed and scrapped instead of the parts being built up from material which is almost entirely used.

There are two further important difficulties with these integral structures. These are:—

(1) The stiffener is normally only an unflanged one because any other type is very difficult to produce by this method. Such unflanged stiffeners have low efficiency under compressive loading, the Farrar efficiency factor being 0.81 instead of 0.95 for Z stringers. In other words, under the same conditions these panels with unflanged stiffeners can be up to 17% heavier than bonded stringer skin panels.

(2) The other difficulty is that mentioned above, i.e., that of crack propagation.

Therefore, a bonded structure remains in principle and in practice in many cases the most attractive type of structure.

TYPES OF ADHESIVE USED.—In the manufacture of important aircraft structures adhesives are practically entirely of the hot-setting type and they are usually based on (thermosetting) phenolic resins. As phenolic resin in itself is brittle and does not make a sufficiently tough bond, there are always other materials present in the adhesive. In the case of Redux this is polyvinyl formal, or Formvar, which is a very tough thermoplastic resin; and in other adhesives polyvinyl butyral, or various types of rubbers, have been used. Epoxy resins have also been used for primary structural applications, both in the U.K. and abroad, but not on the same scale as the phenolics.

It is perhaps a rather remarkable fact that although Redux was devised so many years ago, it remains one of the simplest adhesives to use and its environmental resistance has been unsurpassed. Table 1 shows the results obtained by the Royal

TABLE 1. Tropical Exposure Tests on Redux in Nigeria.

Mean failing loads of groups of ½-in. lap joints, 1 in. wide of 20 s.w.g. L73.	
Control	2,022 lb.
After 6 months' exposure	2,061 lb.
After 1 year's exposure	2,024 lb.
After 2 years' exposure	2,101 lb.
After 3 years' exposure	2,131 lb.
After 4 years and 9 months' exposure	2,139 lb.

Ref.: R.A.E. Farnborough, Tech. Note Chem. 1349

Aircraft Establishment on tropical exposure of Redux-bonded joints and it is seen that after four years and nine months of exposure there is no drop of strength. These results are quoted as being relatively recent (R.A.E. Technical Note Chem. 1349), but are only representative of many other tests under varied conditions.

A development which has taken place in recent years has been the introduction of film adhesives. Although the separate application of liquid and powder Redux is simple enough and has given very reliable bonds, the combination of these by machine into a single film has effected a further simplification of the application procedure and at the same time an increase of peel strength and reduction of scatter has been brought about (Table 2).

It is also found that film has greater ability to take up variations of fit of parts. In view of these advantages, it is disappointing to find that film adhesives have not yet been adopted further for metal-to-metal bonding in this country.

TABLE 2. Comparison between Redux 775 liquid and powder and Redux film 775.

	'Redux' 775 Liquid and Powder	'Redux' Film 775
Mean shear strength (½-in. lap joints of 16 s.w.g. clad 2024-T3)	5,080 lb./sq. in.	5,020 lb./sq. in.
Standard deviation	583 lb./sq. in.	381 lb./sq. in.
Mean peel strength by CIBA (A.R.L.) peel test. (1-in. wide, 20 s.w.g. L72)	45.2 lb.	59.1 lb.

The other field in which research and development effort has been especially concentrated in this country is that of high-temperature adhesives. The limitation on a normal type of adhesive such as Redux is that the thermoplastic component softens at a relatively low temperature so that other modifiers for the phenolic resin are necessary if temperatures of the order of 150° C. and more are to be achieved in service. It is difficult to find modifiers which allow the adhesive to retain both toughness and simplicity of use, but reasonable compromises have been reached mostly by the use of phenolic epoxy combinations in the form of film adhesives.

Fig. 2 shows a plot of strength against temperature for Hidux 1197A which is a modified phenolic film adhesive. It is seen from this figure that, for short times at any rate, good strengths can be obtained up to about 300° C. This is very satisfactory for a large number of missile applications.

For supersonic transport aircraft applications, however, very long soak times (over 10,000 hr.) are required and here a problem arises in that the adhesives tend to deteriorate over a

* Manager, Bonded Structures Division, CIBA (A.R.L.), Ltd.

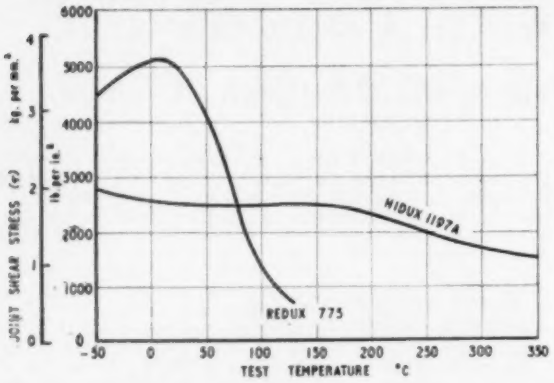


Fig. 2. Variation of shear strength with temperature for Redux 775 and Hidux 1197A.

period of time. Much testing is in progress on this problem, but Fig. 3 shows a preliminary plot of strength against soaking time for Hidux 1197A—from which it will be seen that while good strengths are retained for 1,000 hr. at 150° C., there is a marked drop over the first 500 hr. at 200° C. Also superimposed on Fig. 3 is a curve showing an experimental modified epoxy adhesive which is seen to retain strength better.

Stainless steel appears to have a catalytic effect on organic adhesives and the drop of strength is usually more marked. However, the experimental adhesive shown in Fig. 3 also retains its strength well after 1,000 hr. at 200° C. on stainless steel.

Hidux is as easy to apply as Redux and can be used in the same bonding equipment. It has already been used in production on aircraft and missiles giving very satisfactory results. In the U.S.A. phenolic epoxy adhesives of a similar type, but with rather less simple application and storage conditions, have been used successfully in production, for example, on the Hawk missile and the Convair B-58 aircraft.

Equipment.—Early bonding work in this country was done by means of steam-heated presses and these are still extensively used either with steam, electrical or high-pressure water heating. They give very reliable bonds and a quick operating cycle and are especially suitable for flat panels.

Generally speaking, however, the autoclave is a more adaptable curing medium and it is especially suitable for bonding curved components. A recent autoclave is that shown in Fig. 4 installed by the Armstrong Whitworth company in Coventry. The German manufacturer of this equipment (Scholz of Coesfeld) has supplied similar autoclaves to Fokker in Holland and also to Italy and Germany. The de Havilland company, however, has continued to concentrate its efforts on press bonding.

Inspection.—The difficulty of inspecting bonded parts has certainly been one of the major factors in the slow adoption of bonding in this country. On the other hand, experience has shown that with careful control of the process, combined with the use of test pieces and a superficial inspection of the bonded components, very satisfactory results can be obtained. For example, in the production of the de Havilland Dove more than 22,000 components have been produced for some 500 aircraft and there has never been a bond failure of one of these panels in service.

Nevertheless, some reliable non-destructive test is clearly desirable and in the past few years effort has been devoted, in the U.S.A. and Holland especially, to the application of ultrasonics to this problem. The most promising instrument developed so far seems to be the Fokker bond tester which gives a direct reading of bond quality, detecting degrees of cohesion of the bond with a claimed 95% certainty of predicting the

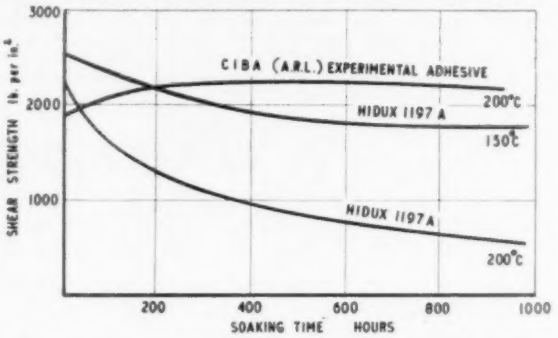


Fig. 3. Preliminary results of the effect of heat-soaking on the shear strength of Hidux.

shear strength within ±570 lb./sq. in. Reliance must still be placed on process control for the adhesion strength.

Applications of Metal-to-metal Bonding.—Redux has now been used in more than 70 types of aircraft and recent applications include the Comet 4, the Trident, the Fokker Friendship (Fig. 5), the Armstrong Whitworth Argosy (Fig. 6), the Vickers Vanguard and the Vickers VC.10. An interesting experimental panel, for British Executive and General Aviation (BEAGLE), is shown in Fig. 8.

In the U.S.A. metal-to-metal bonding has been much less extensively used in primary aircraft structures, although Scotchweld adhesive is used in the wing of the Convair 880 to add strength and at the same time aid the sealing of the fuel tanks. To date, the only U.S. aeroplane relying extensively on adhesive for metal-to-metal joints in the primary structure, is the Fairchild F.27 built under licence from Fokker.

American helicopters, on the other hand, have made good use of bonding to improve the fatigue life, and some of the Bell blades are especially interesting. Similar work has been done in Europe and the Netherlands Helicopter Industries Kolibrie (Fig. 7) and the Sud Aviation Alouette (Fig. 9) for which more than 1,500 blades have already been made, are good examples.

Although the German aircraft industry is as yet in a fairly early stage, some very interesting results with bonding have already been achieved as, for example, in the Blume 502 touring aircraft which used bonding as an assembly method for the complete wing. This is an excellent example of what can be achieved with very simple equipment provided that the structure

(*Continued on page 633*)

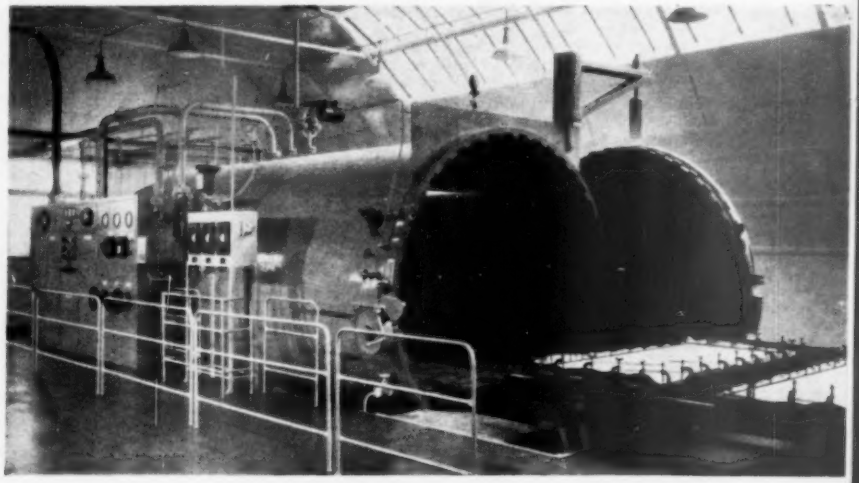
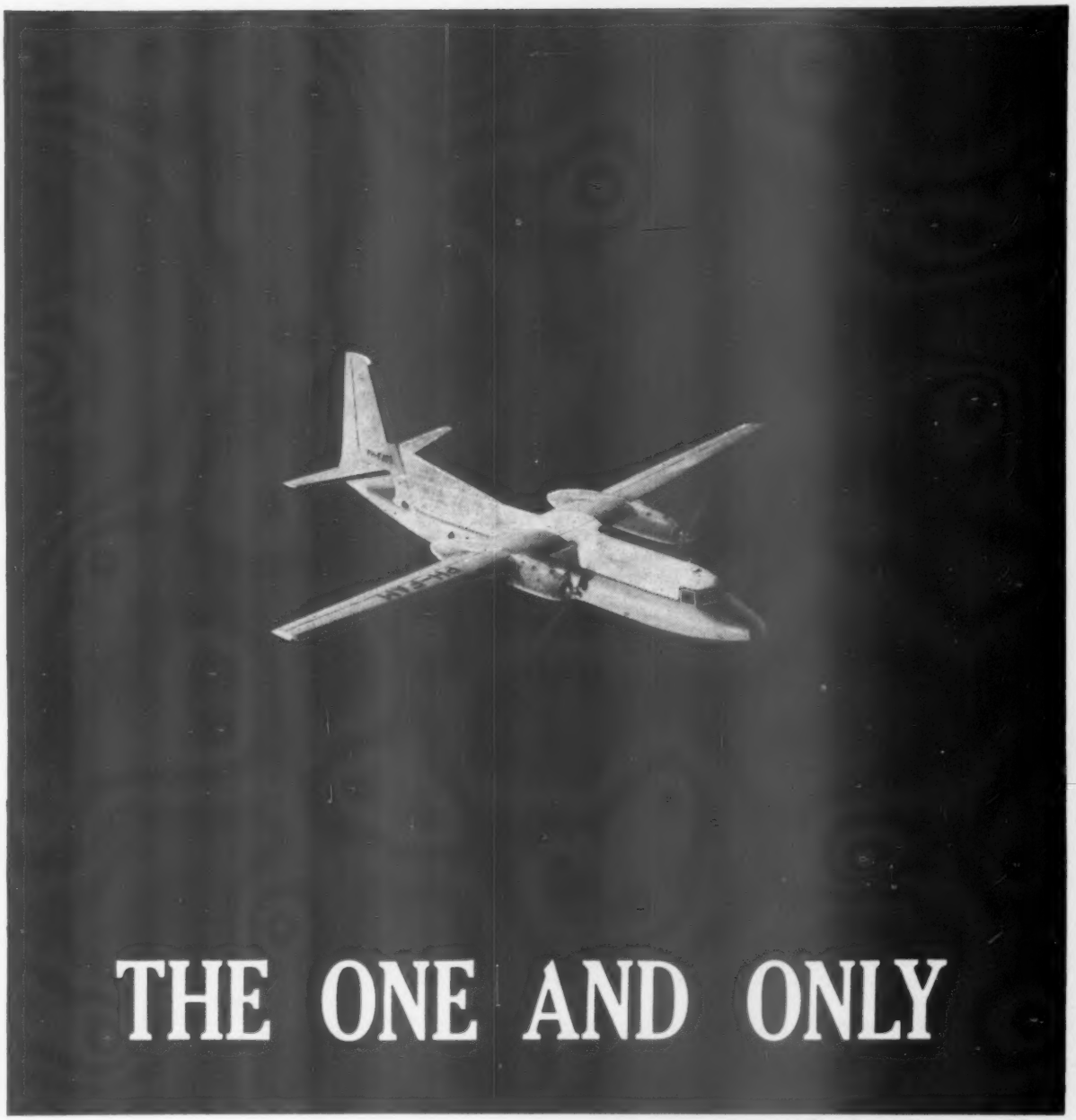


Fig. 4. An autoclave installed in the Armstrong Whitworth factory at Coventry for use in the production of Argosy components. It was manufactured in Germany and is similar to equipment used by Fokker in Holland.



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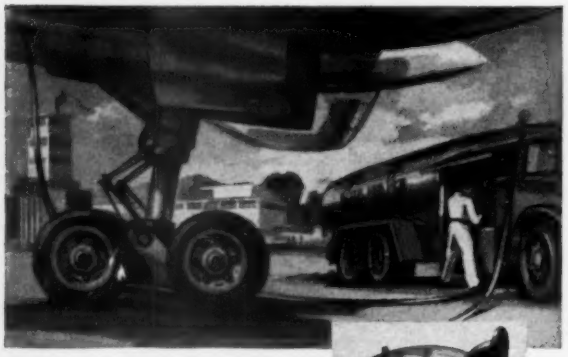

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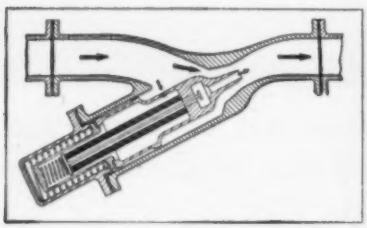

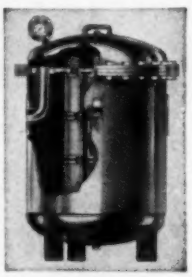

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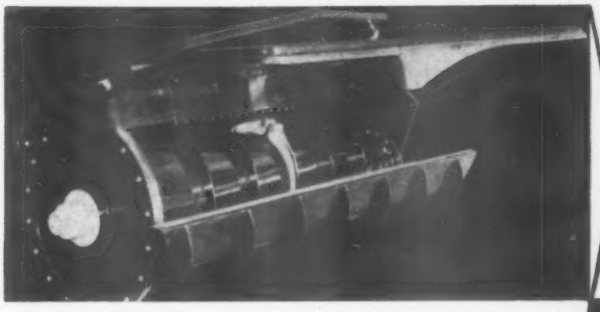
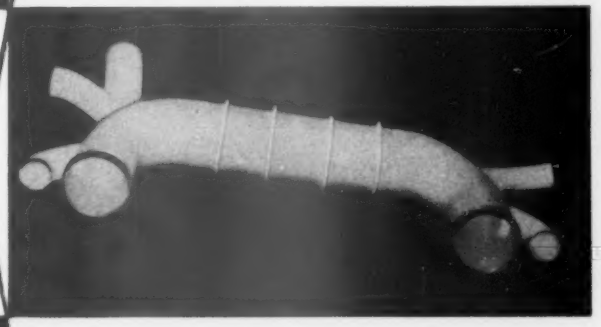
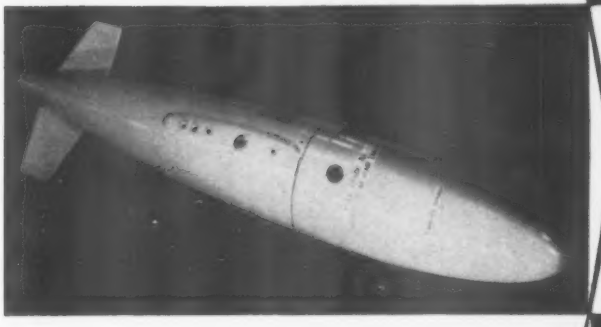


SCANNER Indicative of the exceptional development facilities within the BAPL organisation, this high-speed radar scanner was manufactured to M.O.S. precise specification. The use of plastics resulted in an instrument of higher operational efficiency—with lower manufacturing costs—than an all-metal counterpart.

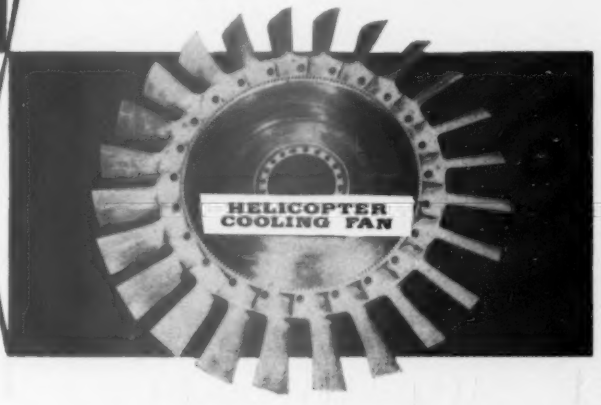
DUCTING Complex shapes of ducting, in plastics, for aircraft air-conditioning systems require the combined aerodynamics and plastics experience implicit in the BAPL organisation. An example of the successful use of glass fibre laminates in this field is the complex ducting system manufactured by BAPL for the Bristol Britannia.





DROP TANKS Plastics drop tanks, designed and manufactured by BAPL, have the same strength and weight as their metal equivalents, but are cheaper to make and more easily stored and handled. The Bristol plastics drop tank was the first to gain full Air Ministry design approval ; they are entirely satisfactory at supersonic speeds and fully combat rated.

COOLING FAN Another example where the use of plastics materials has resulted in a component with characteristics markedly superior to a metal or alloy equivalent. This glass fibre engine cooling fan, fitted to Bristol Sycamore helicopters, is used in conjunction with a collector air duct assembly which, manufactured from glass cloth and polyester resin, is another example of BAPL research and development.



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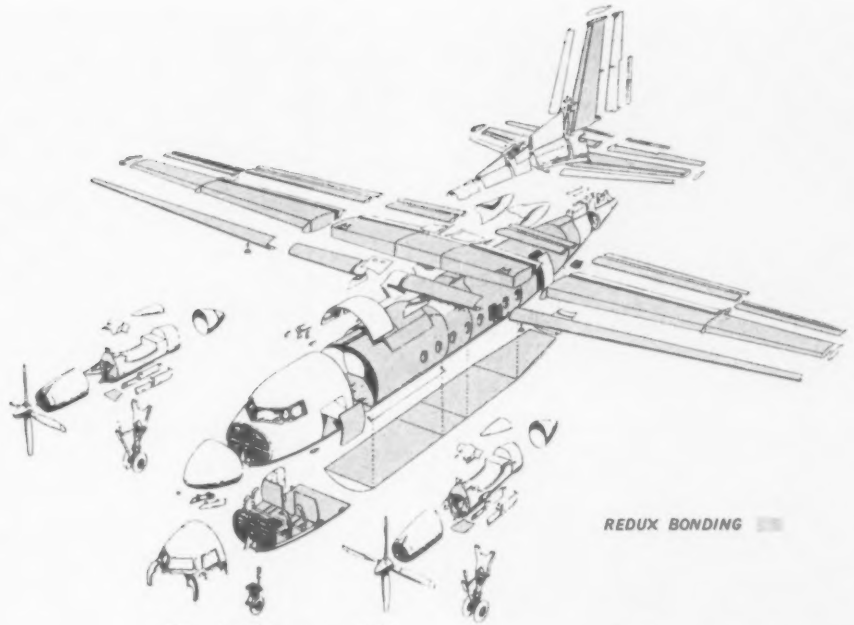


Fig. 5. An exploded view of the Fokker Friendship/Fairchild F-27, showing parts of the airframe in which the Redux-bonding process is used.

REDUX BONDING

Fig. 7. The root end of a rotor blade of the Netherlands Helicopter Industries Kolibrie; it has a total of 10 Redux-bonded laminations to provide extra thickness for blade attachments.

(*Continued from page 632*)

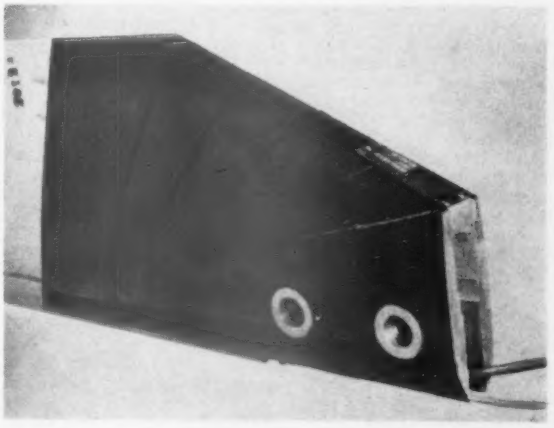
is designed for bonding. There is no doubt that the German industry is now beginning to consider bonding very seriously for its aircraft structures and, as in the case of the Netherlands industry, it is able to plan from the start for this process.

Honeycomb Sandwich

REASONS FOR USE.—The well-known basic property of sandwich structures is that it enables thin sheets to be stabilized up to high stresses. It was found worth while on the Mosquito aircraft, for example, to use a balsa-cored plywood-faced sandwich to achieve a high strength to weight ratio; but as the material density goes up, from that of wood to that of aluminium and to that of steel, the advantages of sandwich construction for weight saving rise considerably because problems of stabilization with any other structure become more severe.

The advantages applying to honeycomb sandwich are largely those of metal bonding, but with rather different emphasis. Apart from the excellent stabilization of thin skins up to high loadings, there are also the advantages of smooth skin surface, a much reduced number of parts (with associated reduction of design time and other paper work), and high stiffness and resistance to buckling which has, for example, enabled aerodynamic interchangeability of trim tabs and control surfaces.

A further important advantage in jet aircraft is the high resistance of sandwich to sonic fatigue. The results of some Boeing work on this subject are shown in Fig 10.



Honeycomb sandwich is especially applicable to structures which have light or medium loadings and further theoretical work remains to be done to define the exact conditions under which sandwich gives the lightest weight. The type of work which is helpful is illustrated in Fig. 11 which shows that over almost the entire loading range (structural index) honeycomb sandwich shear webs are much lighter than the conventional "tension field" or shear resistant types. These curves have been derived by CIBA (A.R.L.) and confirm other work (see NASA Tech. Note No. D-162). Already much design data is available in reports and in data sheets produced by the Royal Aeronautical Society and by CIBA (A.R.L.).

MANUFACTURE OF HONEYCOMB.—This is carried out on two basic methods: (a) corrugation; and (b) expansion. These are discussed elsewhere.

The corrugation method has the advantage of enabling production of thick slabs (Aeroweb honeycomb, for example, is made in blocks 4 ft. 6 in. by 1 ft. 6 in. by 19 in. thick, which are afterwards cut to thickness requirements). On the other hand the expansion method lends itself to automatic production of large quantities and also aids the cutting of close tolerances on thickness. The biggest production in this country at present is by the corrugation method but production by the expansion method is rapidly growing in importance, and Aeroweb, for example, is now produced in both forms.

Initially, the foil material used in aluminium honeycomb was BS 1470 Type S1C (commercially pure aluminium) but this was soon replaced by Type NS3 (1.25% manganese), which has

Fig. 6. Part of a fuselage frame of Armstrong Whitworth Argosy, in which bonded laminations are used.

higher strength, and this type of foil remains the most widely used. For greater strength at room temperature, however, and especially for strength and strength retention at elevated temperatures the magnesium-containing foils are more satisfactory (bearing in mind that the foils must also be corrosion resistant).

Table 3 shows the comparative strengths of NS3 and the American foils 5052 (2.5% magnesium) after soaks at high temperature. Unfortunately, these stronger foils are difficult to roll and there is no suitable supply of them available in this country so that it has been found necessary to obtain them either from the U.S.A. or from the Continent.

TABLE 3. Strength of aluminium alloys suitable for the manufacture of honeycomb.

Material	Strength (lb./sq. in.)			
	At normal temperature		At 150°C. after 10,000 hour soak at 150°C.	
	Yield	Ultimate	Yield	Ultimate
3003-H18 (British equivalent: BS1470 Type NS3)	26,000	29,000	14,500	22,500
5052-H36	34,000	39,000	27,000	32,000

Ref.: Aluminum Data Book, Reynolds Metal Company, U.S.A.

In manufacturing the core, the same problem arises as in metal-to-metal bonding—in that the adhesive normally used for bonding the nodes is not suitable for service at elevated temperatures. CIBA (A.R.L.) has therefore devised a special node bonding resin which gives sufficient shear strength at 150° C. to ensure that the core will not fail in shear of the node bonds. Honeycomb bonded with this resin, Aeroweb Type H as it is called, is rather more difficult to handle than standard Aeroweb but it has generally been found suitable for normal shaping operations.

ADHESIVES.—For bonding cores to skins, similar materials are used as for metal-to-metal bonding. Environmental conditions are similar to those of metal bonds, but on the other hand the strength requirements are somewhat different. In particular it is necessary to obtain a good peel and tensile strength for the core-to-skin bond and this is usually done by using a good filleting material as a core primer, together with a film adhesive for bonding core to skin.

The weight of adhesive is particularly important in honeycomb sandwiches because of the large area of adhesive involved. For this reason special lightweight films have been developed

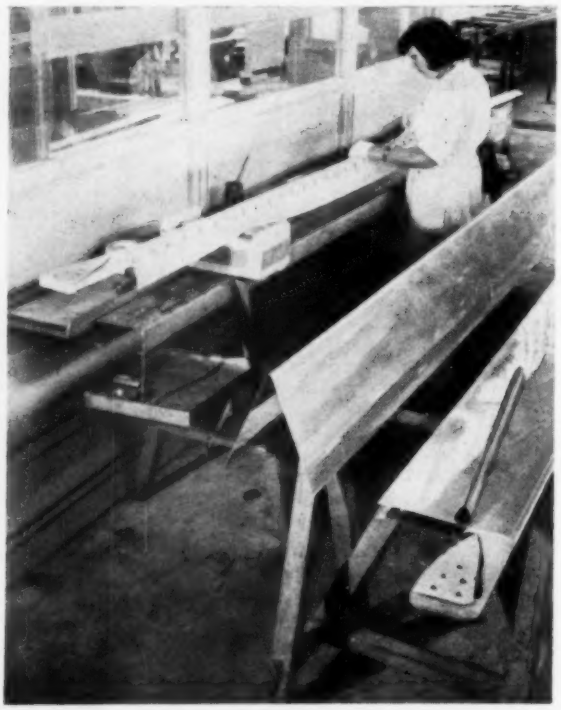
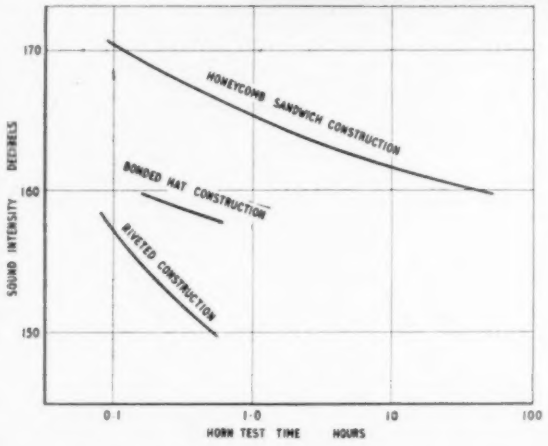


Fig. 9. Parts of the Alouette II rotor blade before assembly.

Fig. 8. Right, an experimental bonded panel for British Executive and General Aviation. The weight saving and simplicity of this sort of structure show to particular advantage in the smaller airframes.

Fig. 10. Below, the sonic fatigue life of typical trailing-edge structures; the results of some tests by Boeing.



(0.035 lb./sq. ft. of film instead of 0.08 lb./sq. ft. of standard film) and these are now extensively used.

EQUIPMENT.—Although uniform slices of honeycomb are easily cut on a high-speed bandsaw, a number of special shaping methods has been investigated for more complicated shapes. One method which has been very satisfactorily adopted is the so-called "valve stem cutter" which is suitable for cutting tapers and rebates as shown in Fig. 12. More complicated shapes have been cut by filling the core with wax or other material, but further development work remains to be done on these cutting methods. For bonding the cores to the skins, the same equipment as for metal-to-metal bonding is used, the autoclave being an especially suitable tool.

It should be borne in mind that frequently, because of the thin skins, a relatively low pressure can be used in bonding honeycomb sandwich. Indeed there is a danger of collapse of the core if too high a pressure is used.

APPLICATIONS.—One of the earliest uses of honeycomb sandwich was for aircraft flooring, but more important structural uses have followed, notably in the U.S.A., where 90% of the skin surface of the Convair B-58 has been constructed of honeycomb sandwich. In this country the control surfaces of the Vickers Vanguard (Fig. 13) embody sandwich panels.

(*Continued on page 635*)

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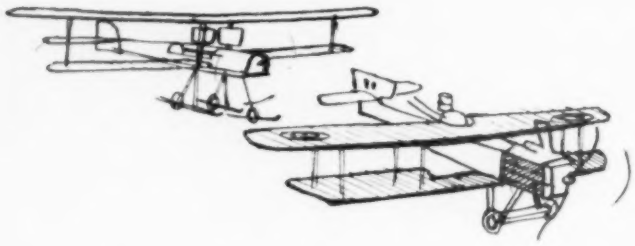

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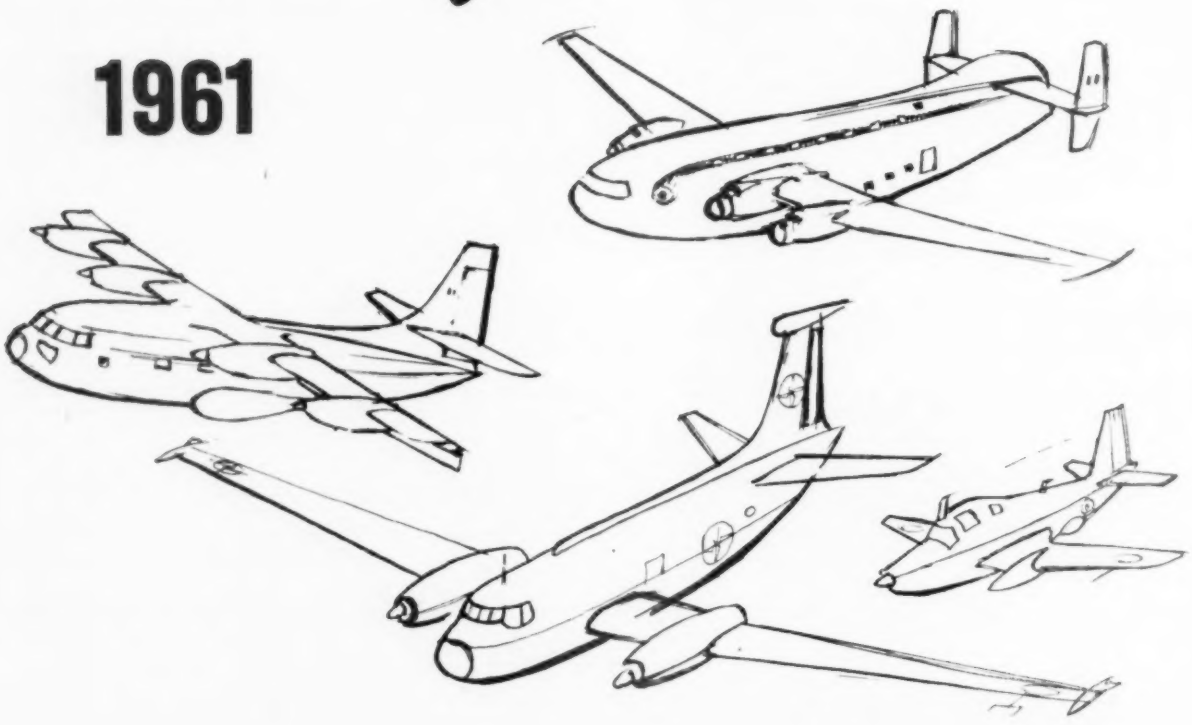


(*Continued from page 634*)

Earlier Vickers experience was obtained with the control surface tabs of the Viscount and these have proved themselves very well. These tabs have been installed in 66 Viscount aircraft of the 810 series and since the first aircraft commenced service in May, 1958, a total of 210,000 flying hours have been accumulated satisfactorily in many parts of the World without any defects having been reported. Although a relatively small use of sandwich, this is certainly one of the most useful backgrounds of service experience available of this type of construction. Currently Vickers are designing and manufacturing large Aeroweb parts for the VC.10.

Almost all companies in the U.K. are now using some honeycomb and in fact the use has increased by a factor of about six over that of five years ago. On the Continent, Sud Aviation have made some large aircraft components with honeycomb core and obtained good results; and also the Breguet Taon made extensive use of honeycomb. This experience is now aiding the design of complete honeycomb aircraft in France and Germany.

It is unfortunate that the excellent work done by Avro on their Type 720 (see THE AEROPLANE, Jne. 20, 1958) has not yet been followed by all-honeycomb designs in this country. Fig. 13 shows well the simplification that has already been achieved in control surface structures, and wider application must surely follow.

Future Developments

It can be seen from the foregoing that a fairly satisfactory position exists, so far as the basic materials are concerned, for the bonding of metal-to-metal and for the manufacture of honeycomb sandwich for service up to the top limit of aluminium alloys (say a Mach number of 2.2 for long periods). Further increase of speed, however, demands a change from aluminium to titanium or steel and, as already mentioned, the advantages of sandwich construction become more significant as the density of material rises in relation to the intensity of loading. Thus steel honeycomb sandwich is very attractive indeed for delta winged supersonic aircraft. In the U.S.A., the North American B.70 bomber has been designed entirely around steel honeycomb sandwich.

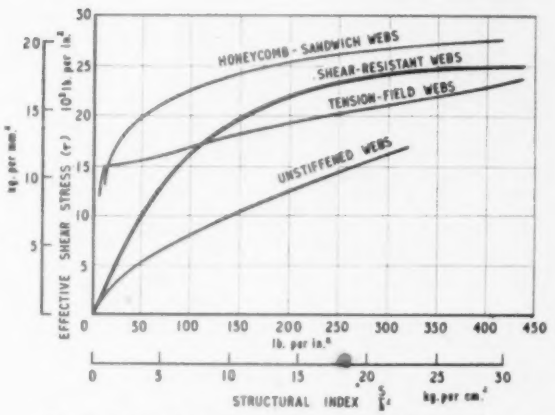


Fig. 11. The efficiency of various types of shear webs.

Unfortunately, no adhesive yet exists which is satisfactory for service in the required temperature range (say 200° to 400° C.) and, therefore, it has been necessary to braze and weld these sandwiches. Such methods demand close tolerances on parts (±0.003 in. and closer), expensive tooling and brazing or welding equipment—so that prices have been very high, ranging from about $700 per sq. ft. in 1952 to about $150 or $200 per sq. ft. at present (see "Present Status Of and Future Outlook for All-Metal Sandwich Construction for Air Vehicles," Stamford Research Institute Project IU-2932). These costs are unacceptably high for a commercial transport and although they may be reduced by improvement of current methods there is no doubt that if an adhesive were made available for this job there would be very great attractions.

Looking at other fields, one can say that the further use of metal bonding would be aided by the development of a room temperature setting adhesive for assembly purposes, but this is as yet some way off, bearing in mind that again the adhesive must be capable of standing up to a very wide range of environmental conditions. For the production of parts there is little attraction to room-temperature-setting adhesives as quicker production can be obtained by the use of heat. For high rates of production, such as may be required on future private or executive aircraft, much can be done to speed up bonding with existing materials and in fact quite good joints have been made with Redux cured in 10 sec. at 250° C.

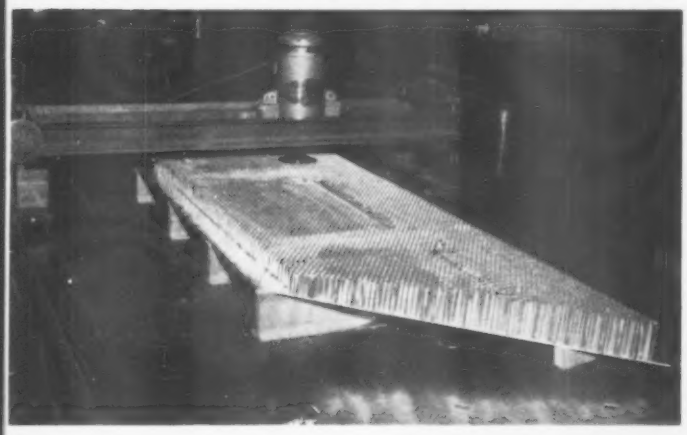


Fig. 12. Tapers and rebates in honeycomb cores may be cut with this "valve stem" cutter.

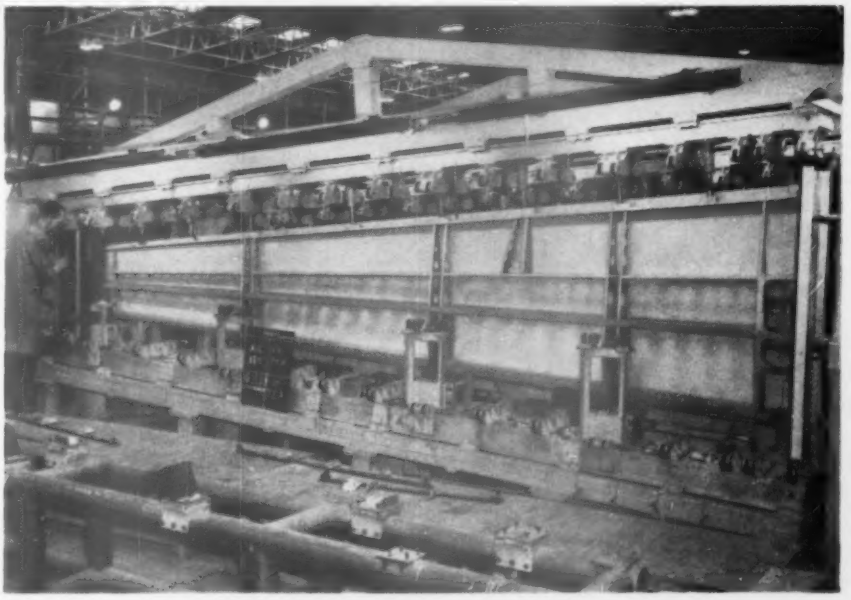


Fig. 13. A Vickers Vanguard elevator before skinning with sandwich; note the small number of ribs. The skin is stabilized with an 0.47-in. thick core of Type 142 Aeroweb honeycomb.

The Agena Satellite

A LECTURE of particular interest was heard by the Astronautics and Guided Flight Section of the Royal Aeronautical Society on May 18. It dealt with the Discoverer programme, and in particular with the eminently successful Agena satellites which form the top component of the Thor-Agena booster in the Discoverer programme and of Atlas-Agena in the Midas and Samos military satellite systems. Not inappropriately, the lecturer was Mr. Ronald Smelt, F.R.Ae.S., chief scientist of Lockheed Aircraft Corporation, which produces the Agena.

Mr. Smelt began by saying that the history of the Agena space vehicle started in the years immediately following the War when the Rand Corporation, under a U.S.A.F. contract, examined the potential applications of satellites, recognizing their technical feasibility as an additional bonus from an ICBM development programme. The Air Force kept this investigation alive throughout the development phase of the ICBM programme; Lockheed actually received its first contract, for detailed engineering studies, in 1955. The Agena spacecraft has grown from these beginnings and is now the vehicle selected for a large variety of U.S. space projects.

Design Criteria

The initial objective, Mr. Smelt explained, was not primarily to satisfy a specific mission in space, but rather to produce a vehicle of which the basic capabilities lend themselves to many space applications already being explored, and probably to many others not yet conceived. Originally, the Agena vehicle was planned to utilize only an Atlas booster. It was recognized in 1957 that, by the use of the Thor IRBM—then at a much more advanced stage than Atlas—it would be possible to make orbital experiments at an earlier stage.

Although the lower relative performance of Thor as a booster greatly reduced the payload capacity of the vehicle, it still offered the possibility of providing earlier engineering data from the basic vehicle.

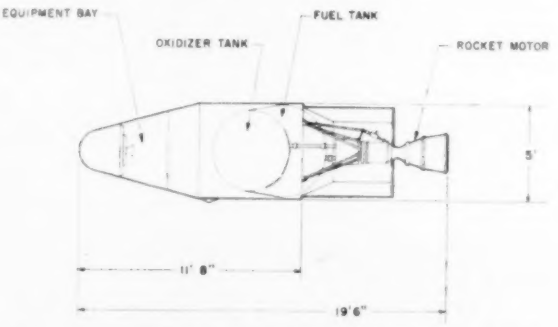
In this way the Discoverer programme was introduced; and flights during the past two years have permitted the engineering development of the vehicle, its precise injection into orbit, and its stabilization and command, to be greatly advanced. It has also been possible to experiment with all three of the techniques which provide scientific and engineering data from the spacecraft; by direct observation from the ground, by telemetering from the satellite, and by recovery from orbit.

Propellent tank for Agena A. The larger Agena B has tanks which are integral with the outer skin.

As is now well known, the Agena satellite combines the orbital equipment with the engine and propellent for the last stage of ascent boost. The entire vehicle is placed in orbit. Much of the internal space is taken up by fuel and oxidizer tanks. An accompanying figure shows how the two tanks are combined into a single unit in the original Agena A vehicle; the tanks of Agena B are larger and have been made integral with the outer skin.

Equipment racks are located in the nose section of the vehicle and also aft of the tanks around the engine compartment. These contain the power supplies and much of the radio and control equipment.

In addition, for those flights in which recovery of experimental equipment is planned, the nose of the vehicle contains a separable capsule with a retro-rocket, heat shield and other devices required to permit it to re-enter from orbit. The



Agena A—overall dimensions. The single gimbal-mounted rocket engine is nominally rated at 15,000 lb. s.t.

radio equipment, some of which is duplicated in the re-entry capsule, includes beacons to assist in tracking, telemetering equipment relaying engineering and performance data back to ground stations, and receiving equipment for commanding changes in orbit.

For the Agena power supply a silver-peroxide zinc primary battery is incorporated as the prime energy source. This battery was developed specifically for satellite operations and incorporates refinements for high efficiency and performance in zero-*g* conditions. For Agena experiments in which months of orbital operation are envisaged, the battery reservoir is recharged by a solar collector. In the Discoverer series, the planned duration of the experiment is only a few days, so that the added complication of recharging is unnecessary.

Rocket Powerplant

A pump-fed rocket engine developed by the Bell Aircraft Company is used in all Agena spacecraft. It was chosen largely on the basis of reliability, having had a large number of development runs, and it has amply justified this selection by a remarkable record of never having failed to start in flight when required. Furthermore, its potential for further performance improvement is considerable. It has already permitted a change of fuel from JP4 to UDMH*, and a number of nozzle modifications, all increasing its specific impulse. In the Agena B it has incorporated a multiple start capability.

Stability and Control

A major feature of the Agena programme has been to develop a reliable stabilization system capable of maintaining the satellite in a specific attitude in space. This system can maintain its position relative to the local vertical while at the same time permitting its attitude in this co-ordinate system to be modified at will by command. The system depends upon attitude information supplied by three orthogonal position gyros. Their signals, combined in conventional manner with rate information from three orthogonally mounted rate gyros, are used to control the vehicle attitude through two alternative control systems.

In Discoverer vehicles when coasting (during ascent or in orbit), the error signals actuate cold gas reaction jets through specially designed proportional gas valves. The jets are fed by a mixture of dry nitrogen and tetrafluoromethane stored at high pressure in a titanium sphere. The pitch and yaw moments

* Unsymmetrical dimethyl hydrazine.

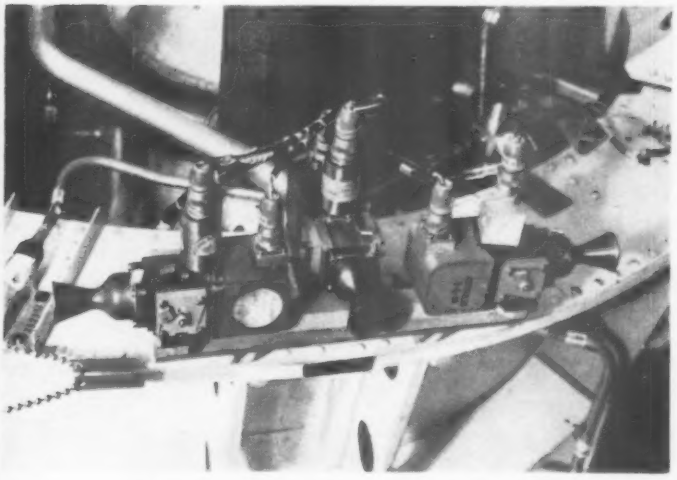
provided by this control system, although adequate for coasting flight, are not designed to overcome the asymmetry of the main rocket engine during propulsion. They are, therefore, locked out when the main motor is operating, and pitch and yaw control is then obtained by two hydraulic servos gimballing the main engine.

The direct actuation of reaction jets for control is somewhat expensive in gas supply, but its simplicity recommends it for short-life operation as in the Discoverer series. For durations of many weeks in orbit the gas jets can be supplemented by a fine control which does not use gas: for example, the modulation of a flywheel. Such a system, said Mr. Smelt, requires the gas jets to be brought into operation only when the flywheel speed goes outside its designed limit.

Manœuvres of the vehicle are commanded by "torquing" the position gyros. In particular, the continuous change in orientation in space required to maintain a fixed reference relative to the local vertical is obtained by applying a continuous torque corresponding to a rate of pitch of about 4° per minute on Discoverer (the typical low-altitude orbit of Discoverer has a period slightly longer than 90 min.).

This steady rate of pitch of 4° per min. is only a rough approximation to the required pitch rate. To provide accurate location relative to the local vertical in pitch, and also to compensate for the drift in all three gyros of the inertial reference package, a continuous indication of the local vertical is provided by a horizon scanner. This infra-red device senses the position of the horizon, during both day and night, and its error signals in pitch and roll are applied to correct the positions of corresponding gyros in the stabilization system.

To measure the deviation in the third (yaw) axis, the steady pitch rate of 4° per min. due to the stabilized motion in the plane of the orbit is utilized. Any deviation in yaw causes a component of this angular velocity to appear in the roll axis, and roll error signal from the horizon scanner can thus be used directly to correct the yaw gyro.



Part of Agena's gas-jet reaction control system; there is a corresponding assembly of three reaction units on the other side.

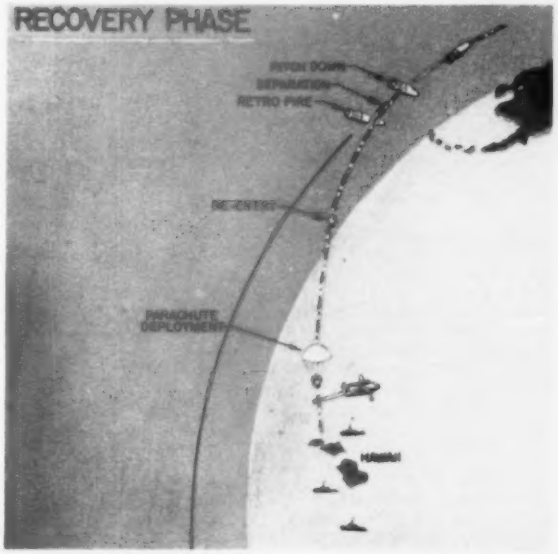
Launch Procedure

All Discoverer satellites have been launched from Vandenberg Air Force Base on the Californian coast. The near-polar orbits possible from this launching point simplify regular contact with the vehicle from a few ground stations.

Injection of a Discoverer into orbit can be divided into three phases. In the first, the Thor booster delivers the Agena spacecraft into a trajectory with an apogee equal to the required injection altitude. Upon separation of the Agena from the Thor booster, the second (coasting) phase begins.

The stability and control system provided for orbit attitude control is immediately brought into action to align the vehicle so that its axis is horizontal, ready for the application of final boost. During the coasting phase the radar track of the first phase is being analysed by a computer at the launching base to determine the actual performance of the Thor booster.

From this data, instructions are transmitted to the Agena vehicle defining the time to ignite its engine, and the velocity increment required in the third (thrust) phase. This velocity increment is measured accurately by an integrating accelerometer of the type developed for ballistic missiles.



Re-entry sequence for the Discoverer capsule. Note that the Agena satellite is orientated at a backward angle of 60° prior to the capsule's ejection from orbit.

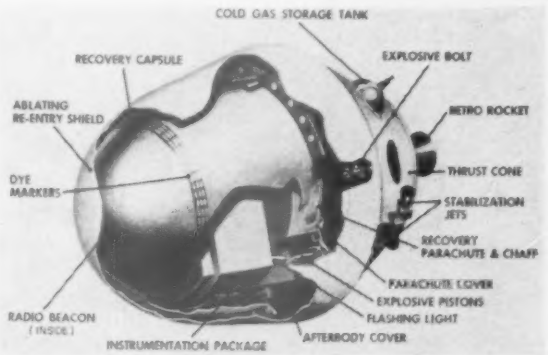
The objective of the radio commands is to arrive at the correct injection velocity with high precision, at the same time as the inclination of the flight path has reached the horizontal at the original Thor apogee height. This injection point at the end of the third phase then becomes the perigee of the resulting satellite orbit.

The multiple restart feature incorporated in Agena B permits a further phase to be introduced to achieve high-altitude, near-circular, orbits. In this technique the satellite orbit selected at the end of the third phase is highly elliptic with its apogee height equal to the final desired altitude. When this apogee is attained, the engine is restarted. A short burst of thrust, only a small fraction of the original impulse in the third phase, then suffices to convert the elliptic orbit into a circle. The only practical difficulty in this lies in observation of the final injection point, which requires a tracking station about half-way around the Earth from the launching site.

Ground tracking is assisted by a beacon in the satellite which also acts as a command receiver, giving position information throughout the period of launching up to the moment of cut-off of the Agena engine—the injection point. Since the satellite is then about 1,000 miles south, and almost on the horizon, the tracking data at this stage is not very precise. It is adequate, however, to give all ground stations information on the time and position at which they should expect the vehicle to appear.

Analysis of the tracking data, and its conversion to information in the co-ordinates of the individual ground stations, must be done in the short time available before the satellite appears at one of the tracking points. This analysis is performed in the U.S. Air Force Satellite Test Center which is adjacent to the Lockheed factory at Sunnyvale, California.

Throughout the flight, this facility acts as the control centre for all vehicle information and operations. It is also



Cutaway drawing of the 300 lb. Discoverer re-entry capsule.

responsible for integration with the scientific community, and maintains continuing contact with the U.S. Space Track headquarters at Cambridge, Mass. The Space Track network is furnished with vehicle orbit prediction, and in turn feeds its observations on the satellite into the Satellite Test Center. Here, two large-scale electronic computers operate in parallel to provide orbital calculations, with complete duplication of peripheral equipment in the interests of reliability.

The first really precise orbital data is provided by a station strategically located on Kodiak Island in Alaska almost at the end of the first orbit. Subsequently, as the orbital plane moves westward relative to the rotating Earth, other stations pick up the vehicle and the electronic computers continually up-date the orbital information and inform the ground stations.

In addition, command functions for the timing of events in the vehicle are developed by these machines on the basis of the orbital data. By the end of the second orbit, the vehicle's path and future history are usually firmly established, and the complete experiment is mapped out, including the selection of the point of recovery for those experiments which include the return of a capsule from orbit.

For the last operation, the problem in the satellite is to apply a small retro-velocity to the capsule with magnitude and direction selected to put the vehicle well inside the selected recovery corridor. A second problem is to arrange the timing of its ejection from the satellite, and the subsequent capsule trajectory, so that the expected margins of error would give final recovery inside a small prescribed landing area, actually a rectangle. This problem is simplified by the fact that there is an optimum initial attitude of the Agena vehicle, about 60° nose-down, which minimizes dispersion due to incorrect vehicle attitude.

The recovery sequence begins with this nose-down movement, initiated at the appropriate position in orbit by "torquing" the pitch gyro. Separation of the capsule then occurs, the retro-rocket delivers the required thrust, and the capsule is ejected into the appointed re-entry corridor.

New Canadian Rockets

A FAMILY of three solid-propellent space research rockets is being developed by the Canadian Defence Research Board. They will be known as Black Brant III, IV and V, and will succeed the previous Mk. I and II vehicles which have been in use for some years. The present models, which are developments of the R.A.E. Skylark upper atmosphere research rocket, have a maximum altitude of about 100 miles.

The new rockets will be capable of carrying instrument payloads to heights of 100 to 600 miles. Models III and V will be single-staged, while model IV will have two stages. A joint team of the Defence Production Department, the Defence Research Board, and Bristol Aero-Industries, Ltd., will be responsible for the development programme. The solid propellent is being produced by the Canadian Armament Research and Development Establishment at Valcartier, Quebec.

It is proposed to conduct initial launchings next year.

Ionosphere Probe

AS we close for press, NASA is expecting to make another attempt to launch an S-45 ionosphere beacon satellite using the last of the 60-ton, four-stage, Juno II rockets. Nearly 40 universities and government laboratories in many parts of the World are participating in this experiment, which is aimed at discovering more about the shape of the ionosphere —where there are concentrations of electrons, and where the ionosphere's profile has peaks or valleys in its structure. New Zealand's Seagrove Radio Research Station is one of the participants; it is part of the University of Auckland.

If the satellite goes into orbit, it will be known as Explorer XII. It will transmit on six frequencies in the 20, 40, 41, 108, 360 and 960 Mc/s. range. By measuring at ground stations the change in polarization or the Doppler shift of the signals, it will be possible to determine the ionosphere electron content between the station and the satellite.

It is hoped to put the 75-lb. satellite into an elongated orbit extending from 240 miles at perigee to about 1,600 miles at apogee.

First "Soft-Lander"

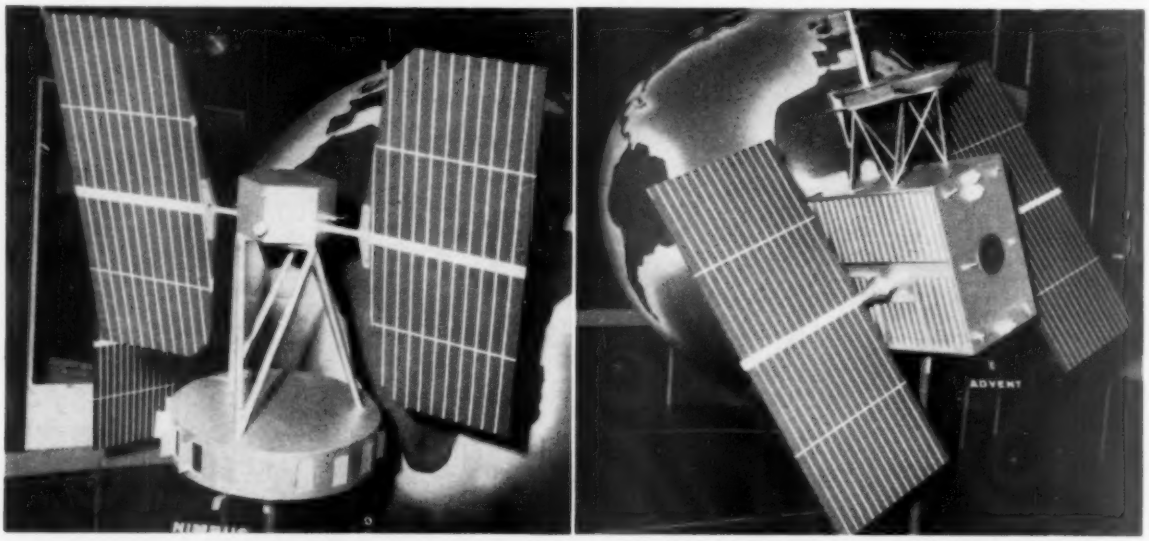
A TEST-VEHICLE of the type of spacecraft which will be required to make soft landings on the Moon was recently tested by the U.S. Navy at China Lake, California. Those who saw it say that the vehicle, which resembles a small water tower, rose off the ground, hovered in flight and landed under complete control. It weighs about 700 lb.

The rocket thrust can be controlled to allow the vehicle to descend slowly on to four shock-absorbing landing legs. A spokesman said that other versions of the engine—one producing as little as 10 lb. thrust and the other 3,000 lb.—had been tested successfully; a 20,000-lb. thrust engine was under study.

Space Pictures in Colour?

ACCORDING to Prof. Pavel Schmakov, the 75-year-old director of the Leningrad Television Institute, Russian specialists are now working on the problem of transmitting colour pictures from space vehicles. "We expect to see the vivid colours of Mars and Venus transmitted to Russia very soon."

Prof. Schmakov, who played a leading part in developing colour television in the U.S.S.R., said that Russia was advanced in colour and that it was hoped to "adapt it to the black and white TV cameras we are now using in our space rockets."



Howard Levy photogr pns

SKY HIGH.—Two major U.S. satellite projects are depicted in these models of Nimbus (left) and Advent (right). Nimbus is NASA's follow-on for Tiros and will transmit photographs of cloud cover and other meteorological data from a 600-mile high polar orbit. Advent will be the first World-wide active communication satellite for the Armed Forces; three such vehicles in a 24-hr. synchronous orbit at 22,300 miles will receive, amplify and transmit messages over the entire globe.

Personal Flying

Latest addition to the range of home-built autogyros is the Saalfeld Skyskooter, a two-seater design marketed by the Saalfeld Aircraft Company, P.O. Box 84, San Diego, California. Plans and kits of parts are being made available by this company for the Skyscooter, which is powered by the 72 b.h.p. McCulloch 4318E two-stroke four-cylinder engine.

Its length is 10 ft., with rotor blades folded, which means that the Skyskooter can be accommodated in most normal garages. With very short take-off and landing runs, it can be used away from airfields, and is claimed to cruise at 65 m.p.h., with a minimum flight speed of 25 m.p.h. Maximum speed is 85 m.p.h., and the ceiling is claimed as 12,000 ft.

Of pod and boom-type construction, the Skyskooter has an empty weight of only 275 lb., the McCulloch engine having a power/weight ratio of about 1 lb./b.h.p. Like the Bensen Gyro-copters, the Skyskooter appears to have an interesting potential, although experience has shown in this country that considerable care and skill are needed to build and operate such craft with safety.

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Miss Sheila Scott has been awarded the Jean Bird Trophy for the most meritorious performance by a woman pilot in 1960. During that year, she flew more than 300 hr. in her Jackaroo "Myth," taking part in the National Air Races, the Air Touring Competition, and numerous air rallies.

She also flew to Tangier, via France and Spain, and has entered in the forthcoming National Air Races.

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A. J. Whittemore (Aeradio), Ltd., of Biggin Hill, have recently completed the installation of a most comprehensive radio "package" in the Dove G-AOFI of the Pressed Steel Company. The equipment installed included a Collins VHF transmitter Type 17L7A and a receiver Type 51X2B; VHF No. 2 trans/rec. 618F-1; VOR rec. 51X3 with indicator 331H; and Marconi ADF Type AD7092D.

Removal of the original radio equipment and its replacement by the more modern items saved some 250 lb. in weight, increasing the payload of the Dove to 1,074 lb.

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In the agricultural field, the F.A.A. has approved the installation of the Gulf Coast W-670-240 engine in the Grumman Ag-Cat crop-spraying-and-dusting biplane. Manufactured by the Gulf Coast Dusting Company of Houston, Texas, the engine is rated at 240 b.h.p. at 2,200 r.p.m., compared with the 220 b.h.p. of the orginal Ag-Cat engine.

The new installation increases the licensed gross weight to 3,750 lb., provides excellent acceleration during turn-arounds and permits operations at higher operating altitudes with greater safety. Four engines are now available for the Ag-Cat; three deliver 220 b.h.p., and the fourth, 240 b.h.p.

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From Sweden come details of the new four-seat monoplane for civil and military use, the MFI-10 Vipan, or Lapwing. Produced by Malmö Flygindustri, in close collaboration with SAAB and the Swedish military authorities, the MFI-10 is a utility aircraft for reconnaissance, aerial photography, ambulance, light transport, and training duties, and incorporates several novel constructional features.

These include a cantilever undercarriage of semi-circular

LAPWING.—The new MFI-10 four-seater from Sweden is unusual in having a bow-legged undercarriage of glass-fibre reinforced plastic which has exceeded expectations during tests. Airframe construction is metal sandwich.

SKYSKOOTER.—This compact two-seat personal autogyro is being offered by the Saalfeld Aircraft Company, California, for home construction from factory-approved plans and kits. Cruising speed is 65 m.p.h.

contours and glass-fibre reinforced plastic, and the use of metal sandwich construction for fuselage, wings and control surfaces. Two sheets of aluminium alloy are separated by a honeycomb of similar material, and are claimed to give better surface finish, more precise contours and cheaper production for large-scale orders.

Maximum speed of the MFI-10 is 150 m.p.h. on its 160/180 b.h.p. Lycoming engine, and its initial climb is 984 ft./min. It was designed by Ing. E. A. Wohlberg, a former designer and test pilot with Focke-Wulf. Malmö Flygindustri have also designed a two-seat tourer known as the MFI Junior.

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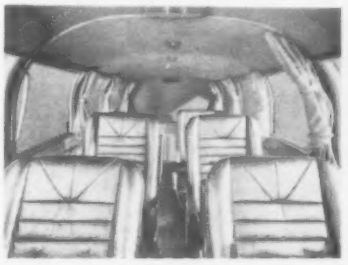
Further details are now available of Cessna's new turbo-supercharged Skyknight, which we illustrated last week. Marketing of this model has been advanced to meet an expansion in business flying, and it is to be available from August, at an f.a.f. price of $67,500. Its 260 b.h.p. Continental TSIO-470-B engines, with turbo-supercharging, give it a service ceiling of 27,200 ft., and a single-engine service ceiling of 17,300 ft. They



SPACIOUS.—Cessna's new turbo-supercharged Skyknight offers comfortable and roomy accommodation for its five occupants in individual seats, as shown here, or including a divan along one side of the cabin.

maintain full take-off power to 16,000 ft., and confer an initial rate of climb of 1,850 ft./min.

For asymmetric operation, the Skyknight has a generator, vacuum pump and system, and an engine-driven fuel pump backed by an auxiliary electric fuel pump for each motor, and its minimum control speed is a low 88 m.p.h. A full five-seater, the Skyknight has a central aisle in the cabin, and ample baggage space in the rear. Its maximum cruise speed at 75% power is 245 m.p.h. at 19,500 ft., over 855 miles on 83 Imp. gal. of fuel.

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We hear from R. K. Dundas, Ltd., that they have taken over as U.K. distributors for Mooney Aircraft. The Mooney company is currently manufacturing the four-seat Mk. 21, which is an all-metal development of the former Mk. 20A, powered by a 180-b.h.p. Lycoming O-360 engine.

At an initial price, in standard form, of $15,995, the Mooney Mk. 21 is far and away the cheapest aircraft of its class in the United States, although its performance and finish compare closely with its more expensive competitors. A Mk. 21 demonstrator is expected within the next few weeks by R. K. Dundas.

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Another new distributorship is that for the French Wassmer Super IV four-seat tourer, which is held for the U.K. by Hants and Sussex Aviation, Ltd. Details of the Wassmer Super IV, sent to us by Mr. H. Best-Devereux and published in our issue of Dec. 30, 1960, show it to be in a similar category to the earlier Mooney Mk. 20, with a wooden laminar-flow wing mounted on a steel-tube fuselage.

Power is also supplied by a 180 b.h.p. Lycoming O-360, which gives the Wassmer a cruising speed of 165 m.p.h. at 75% power. U.K. price is in the region of £7,000, including radio and duty. Mr. Best-Devereux informs us that his interest in the Wassmer Super IV has been confined to technical matters and considerations discussed with the French company in his capacity as an aeronautical engineering consultant.

Gliding Notes

by Dr. A. E. Slater

EVERY day was a contest day throughout the National Championships at Lasham, from May 13 to 22 inclusive. This was such an unprecedented occurrence that Philip Wills said he did not expect to see it happen again in his lifetime.

The first two days have already been described (see THE AEROPLANE AND ASTRONAUTICS, May 18, p. 537), and it was during the second of these that a front came along the Chilterns, baulking those who tried to fly north from the Benson turning-point, and heralding the onset of a week's damp and chilly winds from the North Sea. Each morning was apt to begin with a low stratus overcast, and the forecasting problem was how soon would it "burn off" (a) as the sun got higher and (b) as the air travelled westwards.

* * *

On Monday, May 15, the 50 competitors in League 1 were set a 98-mile downwind race to Dunkeswell, 16 miles short of Exeter, which the retreating front was about to clear by briefing-time. The 40 in League 2 were given free distance, which meant going in the same general direction.

A. J. "Rocky" Stone, holder of two U.K. speed records, made Dunkeswell in just over 2¼ hours at 42.6 m.p.h. in a Skylark 3F, and nine others got there more slowly. In League 2, who were allowed an earlier start, Sgt. K. V. Newholme of the R.A.F. went farthest, 109 miles to Exeter Airport.

At Lasham the sky clamped over at 16.00 hrs. and, according to reports from retrieving crews, it did so suddenly all along the route at about the same time, so that, as Ron Watson pointed out, landing points from E. to W. were arranged in much the same order as launching times.

On this day the R.A.F. overtook the Army in the contemporaneous Inter-Services Championship.

* * *

Distance along a line through Perranporth was the League 1 task for Tuesday, May 16, and, as happened when this kind of task was first instituted in the 1956 World Championships, some competitors thought they had to land at the place through which the line was drawn. A line through Perranporth does, in fact, continue over the sea, but by landing near the N.W. corner of Land's End promontory, five pilots were only four miles south of the line and made maximum possible points short of the Scilly Isles: Philip Wills, Peter Scott, George Burton, Brig. Deane-Drummond and Dr. James. John Williamson was seven miles off the line at St. Just, but made enough points to keep the lead he had held since the start.

League 2 had a 33-mile race to Old Sarum, in which all but two competitors completed the course. It was spectacularly won at 83.4 m.p.h. by Peter Berriman, travelling straight ahead under a powerful cloud street whose lift he could only neutralize by flying at 120 m.p.h. in his Skylark 3. He and John Fielden, both of the Devon and Somerset Club (ex Taunton Vale), only got into League 2 because another entry was cancelled, yet they eventually finished the Championships in second place in their League.

* * *

Next day, Wednesday, it was the turn of League 2 to set off towards Cornwall on "free distance," and Land's End was again within reach. Lionel Alexander landed a mile short of it in the Cambridge Club's Skylark 3F and made the longest distance of 217.7 miles. However, Derek Stowe, of Bristol Club, with 216.3 miles, was the day's winner because his Skylark 2 had a 10% handicap.

Handicapping, by the way, was confined to League 2. League 1 had separate Championships for the Open and Standard (15-metre) Classes.

In League 1 on Wednesday, Flt. Lieut. David Cretney won a race to Wantage and back at 37.4 m.p.h., with John Williamson close behind at 37.3 m.p.h. Sixteen pilots finished the course.

* * *

On Thursday, May 18, there were races for both Leagues: 191 miles down wind to Perranporth for League 1 and 65 miles across wind to Nympsfield for League 2. The Perranporth race was won by John Williamson in 4 hr. 15 min. at 45.2 m.p.h., but only 7 got there this time, compared with the 40 who went to Perranporth or beyond two days before.

Nine reached Nympsfield: John Fielden made the fastest speed, 32.4 m.p.h., but Bernard Davey, in an Eagle, benefited by its handicap and got the 1,000 points. A Bristol Club member flew the course unofficially in the opposite direction in a Swallow, sharing a thermal over Swindon with six official competitors, who were surprised to see him shoot off in apparently the wrong direction.

After spending two nights out of three in trekking back from Cornwall, League 1 were given a rest on Friday, May 19. League 2 had "free distance," and the Duke of Edinburgh, who had paid an official visit in the morning, dropped in again unofficially in the afternoon in his helicopter to see their progress displayed on a map in the control room. Worthing, 39 miles, was the longest distance flown, Alan Purnell getting there in a Skylark 3F under a completely overcast sky.

FINAL RESULTS

			Points
League 1			
1.	J. S. Williamson ..	Olympia 419	7968
2.	G. E. Burton ..	Skylark 3B	7121
3.	P. A. Wills ..	Skylark 3F	6772
4.	A. J. Deane-Drummond ..	Olympia 419	6597
5.	D. H. G. Ince ..	Olympia 419X	5878
6.	Anne Burns ..	Skylark 3F	5818
7.	A. J. Stone ..	Skylark 3F	5811
8.	E. Stark	Skylark 3F	5705
9.	P. G. Burgess ..	Ka-6	5391
10.	P. Scott	Olympia 419X	5292
11.	A. D. Piggott ..	Olympia 403	5284
12.	D. B. James ..	Skylark 3F	5232
League 2			
1.	D. C. Kerridge ..	Skylark 3F	5360
2.	J. S. Fielden and P. E. Berriman ..	Skylark 3	4809
3.	B. J. Davey and R. T. Cole ..	Eagle	4795
4.	B. McA. Bacon and E. W. Clarke ..	Olympia 2	4533
5.	K. V. Newholme and J. R. Chandler	Olympia 2	4476
6.	V. C. Carr and H. Greenway ..	Olympia 2	4327

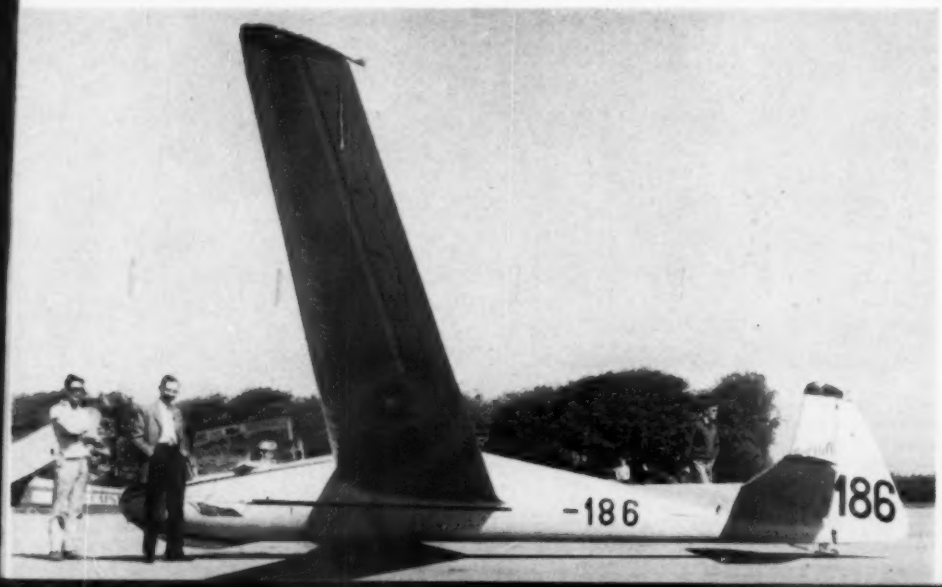
A week after their opening 100-km. triangle race, League 1 were given it again on Saturday, but the other way round—Welford first and Thruxton next. Lift was very poor and the upwind leg to Welford, near Newbury, extremely difficult, taking three hours or more. Of the only four to get round, John Williamson averaged 19.2 m.p.h., Anne Burns 15.9, George Burton 14.5, and Philip Wills 13.8. Anne spent two hours over Lasham waiting for the weather to improve before crossing the start line and Philip spent an hour slope-soaring over the Wiltshire Downs, waiting for the next thermal.

League 2 had distance along a line through Bideford but no-one reached it: Fielden made 67 miles. This task was given to League 1 next day, and seven went beyond Bideford, across the Bay to Hartland Point, Ted Stark being there first.

* * *

The task for League 2 on Whit-Sunday, their last competition day, was "pilot-selected goal." John Fielden won the day with a goal flight to Dunkeswell; Dr. H. N. Gregg of Coventry went farthest, 109 miles to Exeter, but far overflew his goal of Tarrant Rushton, so sacrificing his bonus.

To get them back in time for the prizegiving, League 1 finished on Whit-Monday with a short 65-mile race to Upavon and back, which John Williamson won in 1 hr. 50 min.



A Polish entrant, this Bocian of the Polish A.F.A. was flown during the contests by E. Jerzycki and L. Kurylowicz.

EoN Series IB Type 460

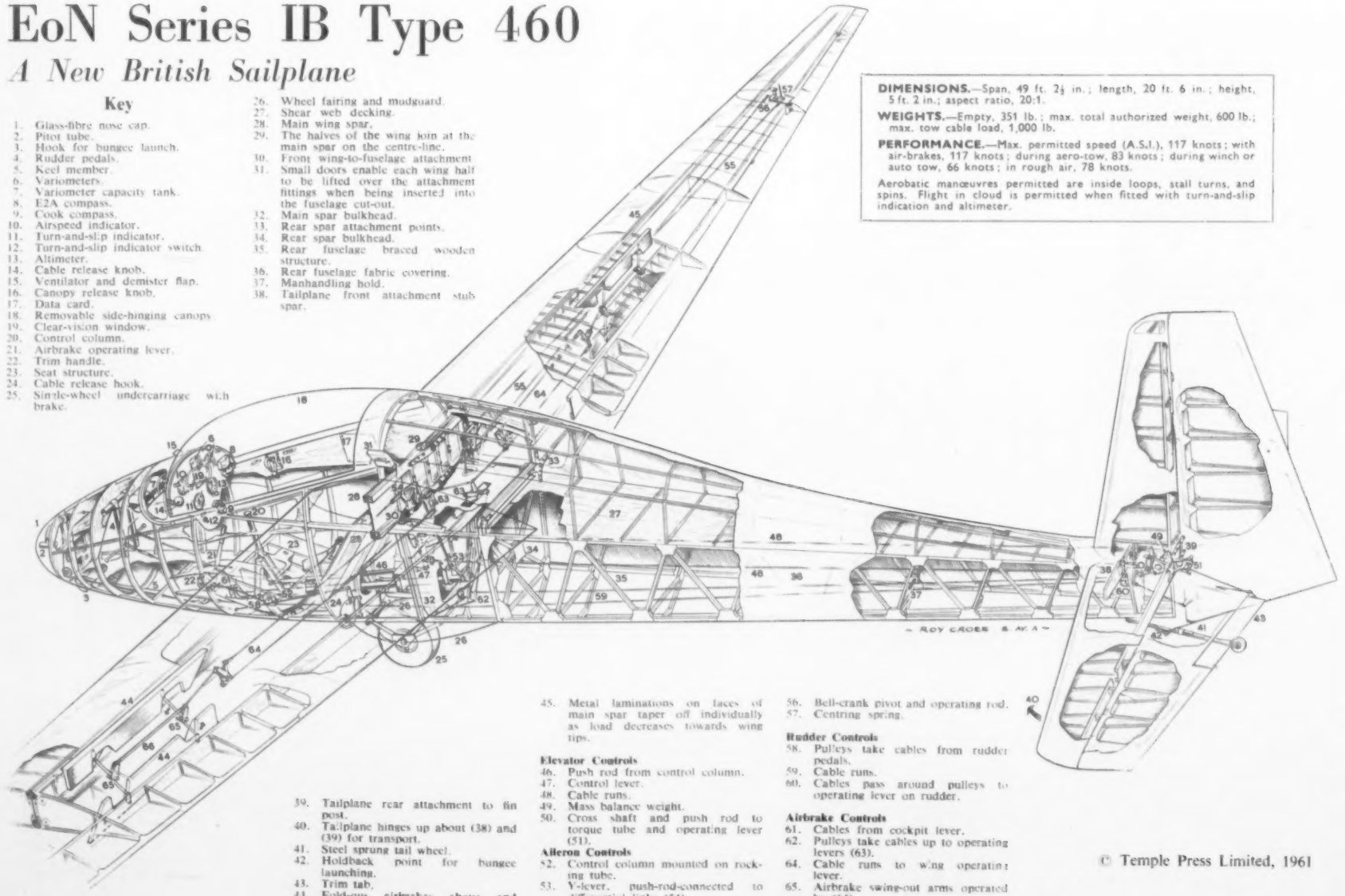
A New British Sailplane

DIMENSIONS.—Span, 49 ft. 2½ in.; length, 20 ft. 6 in.; height, 5 ft. 2 in.; aspect ratio, 20:1.

WEIGHTS.—Empty, 351 lb.; max. total authorized weight, 600 lb.; max. tow cable load, 1,000 lb.

PERFORMANCE.—Max. permitted speed (A.S.I.), 117 knots; with air-brakes, 117 knots; during aero-tow, 83 knots; during winch or auto tow, 66 knots; in rough air, 78 knots.

Aerobatic manœuvres permitted are inside loops, stall turns, and spins. Flight in cloud is permitted when fitted with turn-and-slip indication and altimeter.



Key

1. Glass-fibre nose cap.
2. Pitot tube.
3. Hook for bungee launch.
4. Rudder pedals.
5. Keel member.
6. Variometers.
7. Variometer capacity tank.
8. E2A compass.
9. Cook compass.
10. Airspeed indicator.
11. Turn-and-slip indicator.
12. Turn-and-slip indicator switch.
13. Altimeter.
14. Cable release knob.
15. Ventilator and demister flap.
16. Canopy release knob.
17. Data card.
18. Removable side-hinging canopy.
19. Clear-vision window.
20. Control column.
21. Airbrake operating lever.
22. Trim handle.
23. Seat structure.
24. Cable release hook.
25. Single-wheel undercarriage with brake.
26. Wheel fairing and mudguard.
27. Shear web decking.
28. Main wing spar.
29. The halves of the wing join at the main spar on the centre-line.
30. Front wing-to-fuselage attachment.
31. Small doors enable each wing half to be lifted over the attachment fittings when being inserted into the fuselage cut-out.
32. Main spar bulkhead.
33. Rear spar attachment points.
34. Rear spar bulkhead.
35. Rear fuselage braced wooden structure.
36. Rear fuselage fabric covering.
37. Manhandling hold.
38. Tailplane front attachment stub spar.
39. Tailplane rear attachment to fin post.
40. Tailplane hinges up about (38) and (39) for transport.
41. Steel sprung tail wheel.
42. Holdback point for bungee launching.
43. Trim tab.
44. Fold-out airbrakes above and below each wing.
45. Metal laminations on faces of main spar taper off individually as load decreases towards wing tips.

Elevator Controls

46. Push rod from control column.
47. Control lever.
48. Cable runs.
49. Mass balance weight.
50. Cross shaft and push rod to torque tube and operating lever (51).

Aileron Controls

52. Control column mounted on rocking tube.
53. Y-lever, push-rod-connected to differential links (54).
55. Cable runs in wing.
56. Bell-crank pivot and operating rod.
57. Centring spring.

Rudder Controls

58. Pulleys take cables from rudder pedals.
59. Cable runs.
60. Cables pass around pulleys to operating lever on rudder.

Airbrake Controls

61. Cables from cockpit lever.
62. Pulleys take cables up to operating levers (63).
64. Cable runs to wing operating lever.
65. Airbrake swing-out arms operated by (64).
66. Connecting rod.

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Industry Record

Oxygen and its Uses

The British Oxygen Co., Ltd., has marked 75 years of existence by producing "O for Oxygen," a film illustrating that from Priestley's discovery of the gas in 1774 has stemmed its World-wide use and also that of other industrial gases in industry, medicine, aviation and astronautics and scientific development. The film has a running time of 23 min. and is in colour. The Federation of British Industries and the British Employers Confederation have chosen it as one of the fifteen British entries for showing at the Festival of Industrial Films to be held in Turin in June.

Both 16- and 35-mm. copies of "O for Oxygen" are soon to be available on free loan from B.O.C. to schools, colleges and similar organizations.

Ultra Acquisition

Ultra Electronics, Ltd., has acquired Trix Electronics, Ltd., which, since incorporation on May 1, has been a subsidiary of the Trix Electrical Co., Ltd. Trix Electronics will continue to manufacture and install sound amplification equipment for public address and aircraft intercom systems.

Fire Precautions at A.W.A.

Automatic fire detection equipment has been ordered by Armstrong Whitworth Aircraft, Ltd., from Sound Diffusion (Autothermatic), Ltd. This consists of four independent Auto-thermatic heat-sensitive detection installations of the Mk. IV type. Two of these will be installed at Bitteswell and one each at Baginton and Whitley. In addition a smaller unit is to be fitted in the Bitteswell control tower.

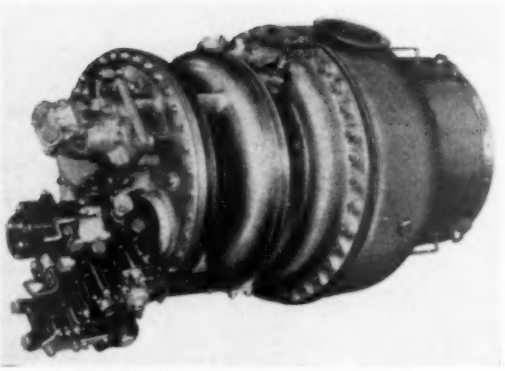
When finished it is expected that the installation will contain more than 13 miles of break link cable detectors. This represents some 23,600 detection points. There will also be a further 880 unit detector heads situated in offices and administrative areas.

Licensed By Shorts

The deposition process employed by Short Brothers and Harland, Ltd., for coating potentiometers with a metal film is to be used under licence by Miniature Electronic Components, Ltd., of Woking. In developing the Seacat surface-to-air missile guidance system the conventional type of potentiometer was found unsuitable for use as part of a cordite-driven displacement gyroscope because a high degree of miniaturization was required. The fineness limits of the resistance wire limited this. Another disadvantage was the way in which the wiper passed over the coiled resistance wire in a series of jumps.

To overcome this, Short's precision engineering division developed a potentiometer in which the resistance wire is replaced by a very fine film of metal. This is less than .000001 in. thick and is deposited on a special high-temperature ceramic by an original high-vacuum technique.

The process takes place in a chamber from which air is evacuated to give a vacuum approaching that of outer space. The ceramic to be coated is placed at the top of the chamber and areas on which no film is required are masked. A small piece of metal, usually nickel chromium, is put on a heating coil and vaporized at a temperature of about 2,500° C. The cloud of metallic vapour rises and condenses on the exposed areas of ceramic in the form of a thin, smooth film.



For use in new military aircraft Blackburn Engines, Ltd., have developed the Cumulus airborne auxiliary power unit from the Palouste.

Altimeters For Aeroflot

What is claimed to be the first Russian order for aircraft flight instruments of Western manufacture has recently been placed with Smiths Aircraft Instruments, Ltd., by the Russian foreign trading organization V.O. Avtoexport, Moscow. This is for 45 Kelvin Hughes 50,000-ft. Type KAA-1603 altimeters to be installed in those

Aeroflot aircraft which operate on routes through and into Western European countries. These are to be fitted as an addition to present Russian altimeters making it unnecessary for Soviet crews to convert altitude readings and barometric settings from metres and millimetres of mercury to feet and millibars.

Fleet Air Arm R/T

To provide ground-to-air communications at an R.N.A.S. station, the electronics division of the General Electric Co., Ltd., has supplied a control console for single-sideband transmitting and receiving equipment. It was designed and built to an Admiralty specification.

Up to 12 transmitters and receivers may be remotely controlled from the console, the switching and audio connections being established over G.P.O. lines some 10 miles long. It may be operated by one or two operators, depending on the conditions of use, and each operator can select transmitter or receiver channels independently by means of key switches.

Loudspeaker monitoring facilities are available, or each channel may be individually selected for headphone circuits to which a mixture of any number of channels may be pre-selected and fed.

Leach Agents

Field Aircraft Services, Ltd., is to act as sole U.K. agent and distributor for the relays and tape recorders produced by the Leach Corpn. of Los Angeles. Leach relays are in use in a number of British and American turbine transports already in airline service and have been specified for the DH.121 and VC10. Leach tape recorders are used in guided missile, ejector seat and rocket sled development. Field Aircraft Services also holds the Bendix Corpn. distributorship for this country.

Flight Planning Aid

In collaboration with R.A.F. Transport Command, Blundell Rules, Ltd., of Weymouth, has produced a flight planning slide rule for use with the Britannia. Originally the idea of Mr. A. A. Munday, the Command research officer, it has been designed with a view to cutting down time spent on constantly recurring calculations. This it is claimed to do by as much as 75%.

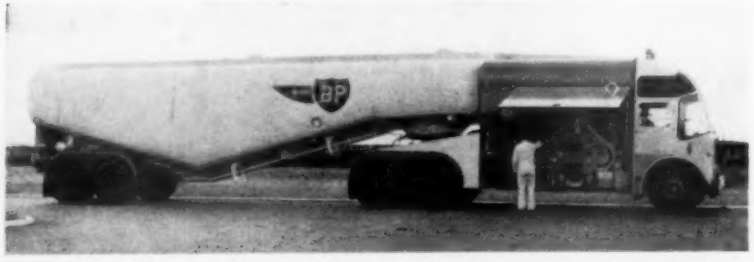
Information provided on the rule includes optimum altitude in conditions of all-up weight, temperature deviation, head wind and wind shear; fuel flow at any altitude and temperature deviation; and a scale for calculating fuel used in a given time at those fuel flows. True air speed for combinations of all-up weight, altitude and temperature deviation (including cruise/climb all-up weight change against time, and cruise/climb altitude and true air speed for temperature deviations) can also be found. Also indicated are climb fuel used, times and mean true air speed for all take-off weights.

Problem Solvers

Two aircraft manufacturers have recently placed orders for computers with Electronic Associates, Ltd. Folland Aircraft, Ltd., is to acquire a PACE 221R and Vickers-Armstrongs (Aircraft), Ltd., is to have a 231R high-accuracy computer for the solution of problems in connection with TSR-2 design.

First Stage Essentials

A Drawing Office Equipment and Materials Exhibition is to be held at the Royal Horticultural Society's New Hall, London, from Jne. 5-8. In addition to the showing of equipment, instruments and materials the organizers are arranging three model drawing offices depicting equipment in varying price ranges.



On the outdoor stand of Hawker Siddeley Aviation, Ltd., at Paris is this 10,000-gal. Yorkshire super-fueller designed and built by Saro (Anglesey), Ltd., for Air B.P. Fuel is dispensed to aircraft at a maximum rate of 750 g.p.m. by pressure underwing refuelling.

Correspondence

Spacecraft Speculations

ASSUMING your correspondent K.W.G. is correct in believing that the Russian spaceship Vostok resembles Spacecraft II in outline, the interior photograph makes an interesting comparison to the external one as reproduced in THE AEROPLANE AND ASTRONAUTICS, May 4 and Apr. 20 respectively.

First, the "porthole with optic orientator" shown by the inside view seems to correspond with the smaller of the two openings revealed by the previous external view. Secondly, the extreme simplicity of the instrumentation and manual override controls suggests that Vostok is not designed to orientate through large angles like Mercury which re-enters stern first.

From there, we can speculate that Major Gagarin's couch or perhaps body-splint held him prone throughout the flight like a bomb-aimer, except perhaps after the inmost capsule had been catapulted clear for a parachute descent when he would be expected to free himself and scramble round to look out of the side-ports. Assuming the Russian astronaut's position was prone with his head among the various devices in the nose, it seems even less likely that the launching technique is the same as the Americans'. The odds seem to be on an air-launch complete with large booster, as previously discussed in this column, and as currently projected in connection with the B.70 programme.

Incidentally, that lift portrayed on the point of hoisting Major Gagarin to the "Spacecraft mounted in the rocket's nose" looks less like a lift than a piece of science fiction or even mining machinery (same article Apr. 20). Most of what the Russians publish is inevitably suspect except perhaps what they give away by mistake.

Cirencester. G. B. BATHURST.

Distances are Relative

YOUR Editorial (Apr. 6) says that L.A.P. is 17 miles from London.

I remember very vividly each milestone on the Bath Road from my early cycle racing days and that Harlington-Coach and Horses crossing, where the New Circular Hotel is now, is the 13th milestone. This is less than ¼-mile from the main entrance to L.A.P. Also this milestone was sited before the Great West Road was cut from Chiswick, and I imagine this to be shorter than the old road through Brentford and Hounslow.

Derby. F. GREAVES.

[According to the *International A.B.C. Air Guide*, L.A.P. is 15 miles from London. The central island site is perhaps a mile from the Bath Road. Wanted, an authoritative ruling on how such distances should be measured: from what point in the airport to what part of the City the airport serves.—ED.]

Britain and Space

I AM fully conscious of the difficulties facing the British aircraft industry as it attempts to adapt itself to the growth of space industries elsewhere, and I have already experienced the privilege of seeing my views on the overall problem widely publicized through the medium of this and other journals. I don't want to labour these views, but I would appreciate the opportunity of now commenting upon some points that have been raised in your columns following the appearance of my article of Jan. 27 last.

Mr. Cleaver's article in reply was both courteous and stimulating. I don't agree with his closing remarks that the alternative to getting into space independently is the abandonment of any space industry and an increasing dependence on tourism. I believe, in contrast, that this nation would overreach itself in economic terms if it mounted an independent programme at this late stage, and the resulting upset would lead to a public reaction against any space activity at all.

I am not against British participation in space vehicle development, as indicated in Mr. Cleaver's communication in the Apr. 20 issue. On the contrary, I am very much for it. The question is—at what level? I have specifically stated that I am opposed, at this late stage, to the development in this country of large booster rockets. There is still scope for our own activity using vehicles broadly of the Skylark and Black Knight type. While it might be of advantage to use developed boosters supplied by the United States, the more obvious need on the larger scale is for a Western World satellite and interplanetary programme directed by the United States and to which we could make distinctive contributions.

Mr. Ashworth in the May 11 issue says that I appear to have no conception of the cut-throat attitude of America towards British industry. I do know that, if we were to explore with them the possibilities of backing-up their programme, they would agree to take us in only if it were to their advantage to do so. This is so obvious that it can hardly be a point of contention. The point that seems to need to be emphasized here is that they are not cut-throat about space activity. The global nature and large scale of astronautics make it a matter

Wroundabout

Keep 'em flying. A joke story sometimes stimulates the profoundest speculation. Like the now familiar one about the motor-van. In between bursts of speed, the driver would pull up, leap out, beat furiously on the sides of the van, scramble back and drive off again. A police patrol, observing this peculiar progress, stopped the van and asked the driver to explain. "Well," he said, "this is a one-ton van and I've got two tons of budgerigars in there." Obviously sound reasoning which might be applied to improving airline revenues—get the passengers airborne *inside the cabin*, fill that wasted space near the ceiling, double your capacity, apply weightlessness. Any questions?

*

Wanted—one Hillerport. Invitation from Helicopter Sales, Ltd.: "Dear Wren—We hope to give a demonstration of the Hiller E4 helicopter at the Battersea Heliport on June 14. We should be delighted to see you there. Yours sincerely . . . . . *P.S.* Westlands cannot now let us use the Heliport. The demonstration will therefore be held at Redhill Aerodrome." Vertical let-down?

*

"One egg on toast—SCRAMBLE!" "Electronics," says that industry's annual review, "provide the key to all modern defence problems. Every part of the fighting system . . . missiles . . . infantry . . . bomber or tea-carrying NAAFI truck, calls for its basic background of electronics (NAAFI now uses stock-keeping computers and fits VHF radio in some of its tea trucks)." This has the making of an impressive operational demonstration at the next S.B.A.C. Display.

*

Dornier Double. A feature of the Paris Show is the two Dornier monoplanes' STOL (Simply Terrific Op-Lift) performance. John Fricker tells me they are the only fixed-wing aircraft with A.S.I.s which read down to minus three knots. Dip.-Ing. Claudius Dornier, son of the pioneer, says that the company is that rare thing in today's aviation, a family concern. His brothers work with him and his father still gives benevolent advice. They accept the limitations of such a set-up and have no plans to challenge, say, Boeings or B.A.C. The Do 28's registration has no significance. Claudius Junior, having led the design team for both craft, is also able to demonstrate his built-in sky-hooks.

*

The Greeks Have a Word for it. A friendly Greek reader who writes to local English-language papers in praise of our aeronautical products, tells me that their printers' language difficulties sometimes have mildly humorous results, such as their Martin-Baker "mobile ejection seat drainer." But a logical name which Armstrong Whitworth might bear in mind is the one unintentionally coined for their successful transport, the "Cargosy."

by Wren

Correspondence . . . .

of advantage to the Americans to have the assistance of other nations. We need to learn to think in terms of a new kind of international realism.

It is certainly true that in contracting out of the development of large booster rockets we become dependent on the United States in this field. Any practical British space activity must be founded on the realization that this is now a necessity.

One may regret that the prizes in high-performance aeronautics and astronautics are going to the big groups, but it is useless to pretend that things could be otherwise. One regrets that astronautics has been so long neglected here. It is unfortunately no good doing the right thing at too late a date, because it then ceases to be the right thing.

The tricky question is—to what extent will the Americans wish to see an active rocket vehicle industry in Britain? The scope of their space exploration programme is so vast, and the competition from the Soviet Union so pressing, that I believe there is room for an appreciable contribution from Britain. This is a vital matter for us at this time, and can only be resolved in detail by thoughtful and considered discussion between the Americans and ourselves, initiated preferably at the highest level.

Mr. Ross, in a letter, says that I am not logical in opposing co-operation with Europe while advocating co-operation with the United States. I believe that there is a difference here. The United States is peopled largely from Europe and intermingling has produced a nation with which all the individual nations of Europe can feel association. For all the enthusiasm displayed in print regarding various European co-operative projects in the fields of science and engineering, the blunt fact is that such projects are on a small scale, and large-scale technological co-operation would be impracticable because of the intense national pride still dominating European politics.

Weston-super-Mare, Somerset. S. W. GREENWOOD.

Preserving Old Aeroplanes

IN a recent letter to *The Times*, dealing with the problem of preserving historic aircraft, Mr. Charles Gibbs-Smith mentioned the possibility of the grounds of country houses being used to store some of these types.

This letter coincided with the handing-over of the last Sunderland by the French Navy, to our Short Sunderland Trust at Pembroke Dock. Even before the "Save the Sunderland" campaign was completed, I had given much thought to other types not yet saved, and had in mind making use of the 10 acres of property here as an aircraft museum.

I have been following up my investigations as to whether I can implement this idea. Provided I get half the co-operation shown in the Sunderland project, I have little doubt that the plan can succeed.

Finally, in Mr. Foster's recent letter (THE AEROPLANE AND ASTRONAUTICS, Apr. 20 last) about the Sunderland's homecoming, he expressed regret that this was not wider publicized. The leading national daily newspapers were all informed, and you, Sir, were kind enough to publish an article about this several weeks beforehand. So we did our best to keep everyone informed.

I think Mr. Foster's idea of a flying-boat reunion at the Dock well worth following up. I am sure the Sunderland Trust will be glad to help.

Pantgwyn Mansion, Cardigan. PETER F. M. THOMAS.

Sunderland Armament

AS an ex-Sunderland pilot, and as still a full-time "boat" pilot, I was most happy to see, from your issue of Apr. 6, that one example of this type is being retained for posterity at Pembroke Dock.

In the article in question I do feel that the final sentence is not correct.

I have never seen a Sunderland with wing-guns, but I have seen many with four fixed Browning .303 guns in the nose, controlled by the pilot with a gun button on the control wheel. These guns, together with the two-gun nose turret, were most effective at times.

Calcutta, India. C. R. CHRISP.

Back to the A.C.C.

WHEN the Air Training Corps was formed in 1940 it was known far and wide as the A.T.C. Now Big Brother Air Traffic Control has pinched the initials the Corps was so proud of. Why not change the title of the Corps to Air Cadet Corps. There's nothing in the list of abbreviations in the new Aeroplane Directory for A.C.C.

The Air Training Corps grew from the Air Defence Cadet Corps of circa 1937, so named when we had to kid ourselves we'd never attack but only defend—disregarding the dogma that attack is the best form of defence.

London, W.14. GEOFFREY DORMAN, A.R.Ae.S.

Publications Received

War Planes of the Second World War, Fighters, Vol. III, by William Green. Following closely upon Vol. II in this valuable series of small reference volumes (see our issue for May 18), Vol. III is concerned with the fighters of Japan, the Netherlands, Poland, Rumania and the Soviet Union. Sixty aircraft types are covered in text, photographs and 3-view line drawings. Notable among the contents are details of the Berezniak-Isaev BI-1, a Russian rocket-powered fighter of 1942, and the Mikoyan I-250, which exceeded 500 m.p.h. in 1945 with a combination piston engine/ramjet power plant. 182 pp. 5¼ in. by 4¼ in. Illustrated. Macdonald and Co. (Publishers), Ltd. 9s. 6d.

Modern Flight Dynamics by W. Richard Kolk. A text book for all concerned with the design of flight vehicles, whether aircraft or missiles, with special emphasis on dynamic motion and stability. The first volume in a new Space Technology series. 288 pp. 6 in. by 9 in. Prentice-Hall International Inc. Price 50s.

ABC Royal Air Force, by John W. R. Taylor. This third edition of a popular title in the ABC series reverts to a smaller page size but loses none of its usefulness. In addition to the principal sections illustrating and describing aircraft and missiles in service with the R.A.F. and the Army Air Corps there are chapters on the history and organization of the Service, and on aircraft markings and designations. 64 pp., 5 in. by 7¼ in., illustrated. Ian Allan, Ltd. 2s. 6d.

Secret Establishment, by Rodney Quest. A readable novel with the development of a supersonic bomber as its theme and a hypothetical Admiralty Rocket-plane Establishment as the setting for its action. 238 pp., 5 in. by 8 in. Published by Hutchinson and Co. 15s.

Tackle Gliding This Way, by John Simpson. A new title in the "Tackle" series, by a well-known British sailplane pilot, who has been instructing regularly since 1938. Covers the theory of gliding and construction of gliders in addition to the practical problems of flying from the first lesson to advanced cross-countries. 128 pp., 4¼ in. by 7¼ in., illustrated. Published by Stanley Paul and Co. 12s. 6d.

Aviation Calendar

Jne. 1

Verona.—Verona Aero Club Rally; until Jne. 2.

Jne. 2

London.—R.Ae.S. Rotorcraft Section lecture, "Development of Stabilizing Equipment for Helicopters," by P. D. MacMahon, in the Lecture Theatre, 4 Hamilton Place, at 18.00 hrs.

Panshanger-Rhoose.—London to Cardiff Air Race and National Air Race heats at Cardiff; until Jne. 3.

Jne. 3

Coulommiers.—Coulommiers Aviation Circle First Brie Rally; until Jne. 4.

Grenoble.—Dauphiné Aero Club Rally; until Jne. 4.

Luxembourg.—Luxembourg Aero Club Second Moselle Wine Rally; until Jne. 5.

Jne. 9

Tarbes.—International Gathering for the Pilgrimage of Wings to Lourdes; until Jne. 11.

Jne. 10

Dieppe.—Dieppe Aero Club International Rally; until Jne. 11.

Company Notices

INCREASE OF CAPITAL

W. S. Shackleton, Ltd. (296,581). Aeronautical engineers, etc., 175 Piccadilly, W.1.—Increased on Aug. 25, 1960, and Sept. 6, 1960, by (1) £1,500 and (2) £47,000, in £1 ordinary shs., beyond the registered capital of £1,500, and £3,000 respectively.

New Patents

APPLICATIONS ACCEPTED

872,215.—**British Messier, Ltd.**—"Aircraft flying controls."—Aug. 14, 1957. (Aug. 14, 1956.)

872,265.—**Recherches Etudes Production.**—"Combined jack and damper for aircraft landing gear."—Aug. 8, 1958. (Jne. 7, 1958.)

Printed specifications of the above will be available on Jly. 5, 1961, and the opposition period will expire on Oct. 5, 1961.

Personal Notices

BIRTHS

Baynes.—On May 14, at P.M.R.A.F. Hospital, Halton, to Gillian (*née* Richards), wife of Flt. Lt. K. Baynes—a son.

Bradshaw.—On May 18, at R.A.F. Hospital, Wroughton, to Janet (*née* Hammersley), wife of Flt. Lt. J. R. Bradshaw—a son.

Gould.—On May 19, at Nuffield Maternity Hospital, Oxford, to Geraldine (*née* Ricketts), wife of Flg. Off. C. E. Gould—a son.

Mellor.—On May 16, at Wunstorf, Hanover, to Rosalind (*née* McLean), wife of Flt. Lt. P. R. Mellor—a daughter.

McKay.—On May 15, at P.M.R.A.F. Hospital, Halton, to Gwendolen (*née* Scuse), wife of Sqn. Ldr. G. Kirkwood McKay—a daughter.

Stack.—On May 20, at St. George's Hospital, Wallingford, to Virginia (*née* Todd), wife of Gp. Capt. T. N. Stack—a daughter.

Tate.—On May 4, at R.A.F. Hospital, Nocton Hall, to Helen, wife of Sqn. Ldr. R. Tate—a daughter.

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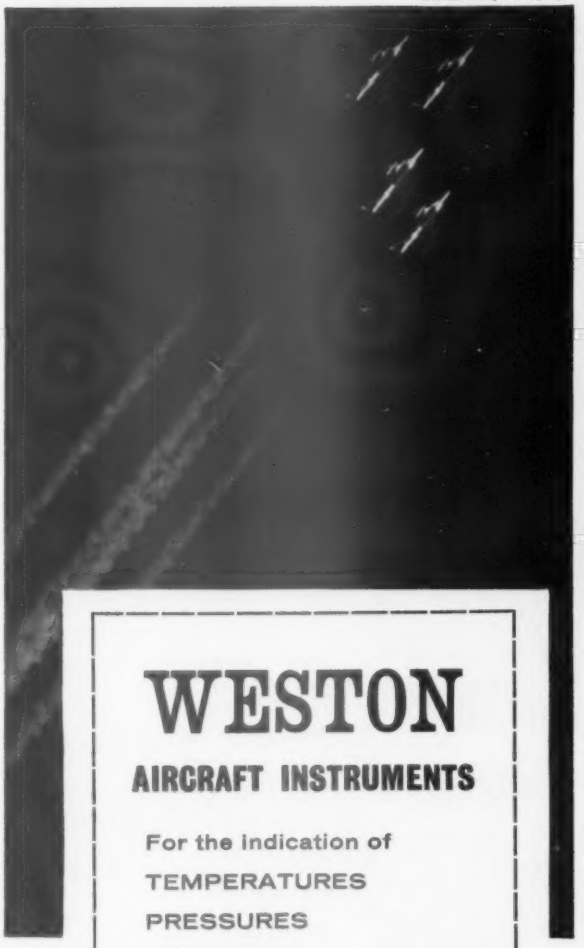

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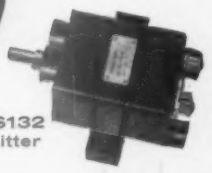

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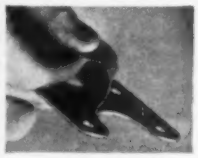

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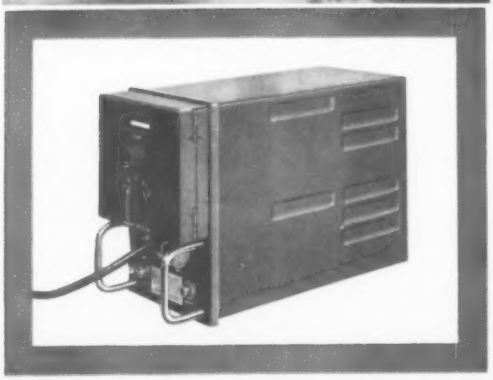

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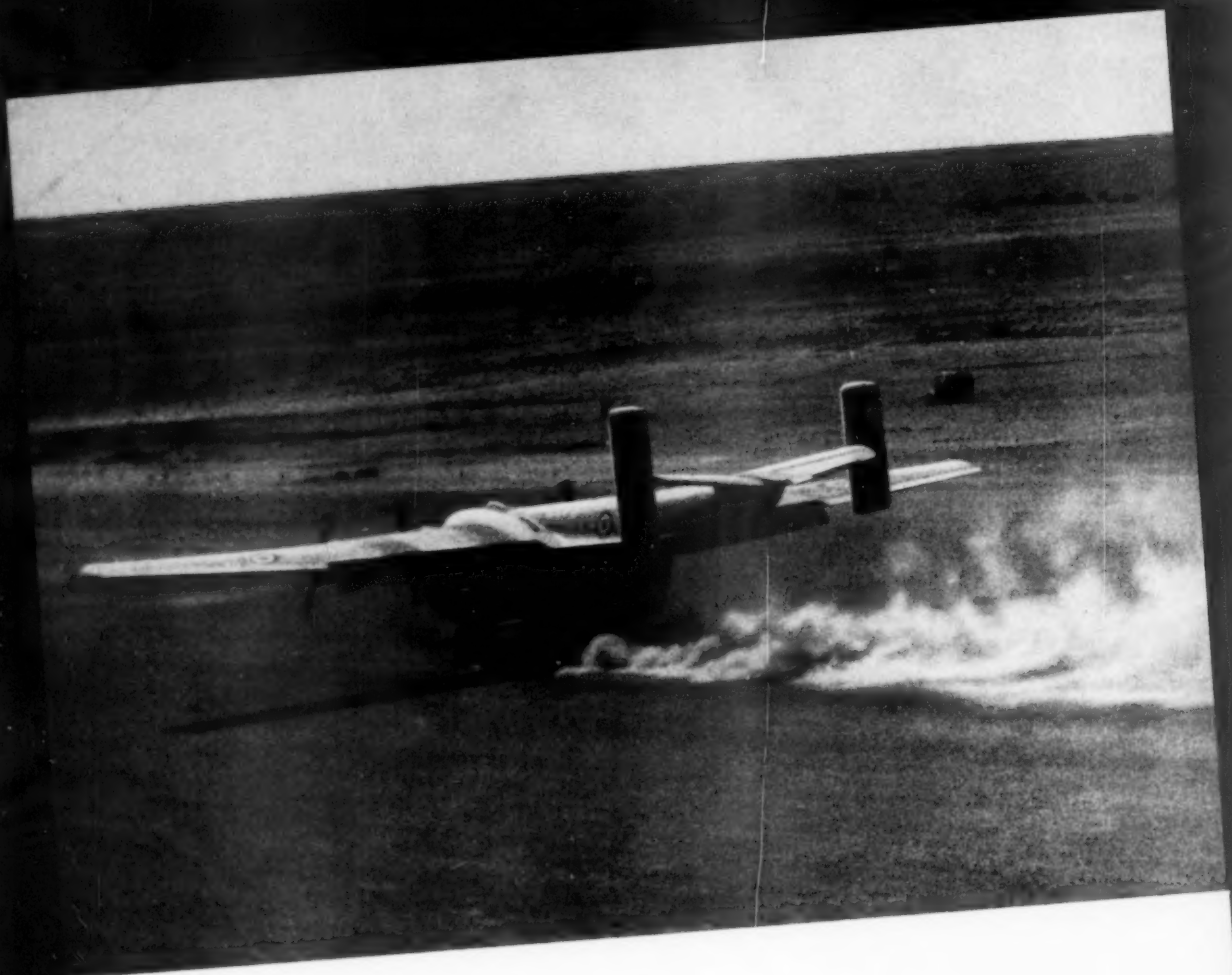

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